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RESEARCH BROADENS VISION OF MARYLAND AGRICULTURE

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SEVENTY-SEVENTH ANNUAL REPORT

BULLETIN A-141

DECEMBER 1965



RESEARCH BROADENS VISION OF MARYLAND AGRICULTURE

SEVENTY-SEVENTH ANNUAL REPORT

1963-1964

**UNIVERSITY OF MARYLAND
CULTURAL EXPERIMENT STATION**

**BULLETIN A-141
COLLEGE PARK
MARYLAND
DECEMBER 1965**

BOARD OF REGENTS OF THE UNIVERSITY OF MARYLAND
AND
THE MARYLAND STATE BOARD OF AGRICULTURE
1963-1964

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UNIVERSITY OF MARYLAND
AGRICULTURAL EXPERIMENT STATION
COLLEGE PARK, MD.

*To The Governor of Maryland,
the Board of Regents,
and the President of the University of Maryland*

I transmit herewith the Seventy-Seventh Annual Report of the University of Maryland Agricultural Experiment Station, as established by Act of Congress, March 2, 1887, containing an account of research and experiments conducted during the fiscal year ending June 30, 1964, and a statement of the receipts and disbursements for the same period.



I. C. Haut
Director

ABOUT THE ANNUAL REPORT

The Annual Report of the Agricultural Experiment Station deals with statements of the progress of technical and scientific investigations conducted by the Station in furtherance of major programs of the College of Agriculture, University of Maryland.

These studies are chosen by department heads and scientists in consultation with the Station Director and are assigned by project numbers for records and for convenience of reference. Every assistance is given to scientists to pursue the investigations wherever they may lead. Detailed information on the findings are reported at intervals, and reports of special merit may be published in technical bulletins, journals, or popular articles.

Each department once a year prepares a condensed account of its findings, for publication in this report, a bulletin of the technical A Series.

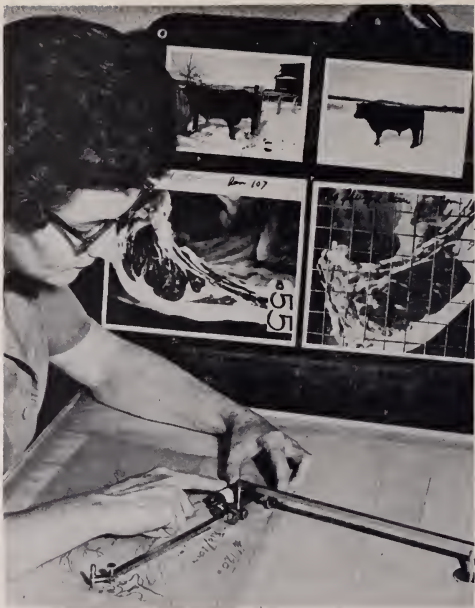
Reading matter and illustrations are expected to give clear pictures of the research achievements of a fiscal year. Pictorial features emphasize functions of research.

The Annual Financial Statement, lists of Staff Personnel, Journal Articles published, Bulletins issued, and the current Research Projects are contained in this report.

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The project number is given after each progress report. The title of the project and the personnel associated with it can be found among the current projects on pages 111-118.

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Planigraph For Measuring Cuts of Meats

Animal Science technician is using a planigraph for enlarging or reducing drawings and photographs in measuring the areas of desirable commercial cuts of meats. The tracer is moved around the outline and the pencil reproduction line follows at any desired scale. A grid is laid over the photograph of a rib eye, and the area of the "eye" is arrived at by counting the squares and partitions of squares. The steak at the left is better than the one at the right. Note the "marbling" and the thinner layer of covering fat.

Formerly only carcass measurements of slaughtered animals were employed. Recent research has developed methods of live-animal measurement for forecasting the yield of desired cuts of meat. Exploratory work continues on measurements of live animals. These measurements and appraisals are expected to be useful in predicting the areas and weight of meat cuts. (Text on Page 42)

RESEARCH BROADENS VISION OF MARYLAND AGRICULTURE

AGRICULTURAL ECONOMICS

Research in the Department of Agricultural Economics is devoted to the application of economic analyses to the problems and opportunities of agriculture; including appropriate areas of farm production, agri-business and consumer demand, and the interrelationships of agriculture and the total resources of the economy. It involves the generation of knowledge on which to base decisions concerning efficient acquisition of farm production inputs, organization of on-farm resources, off-farm marketing processes, and the integration of business, human and other resources related to agriculture, so as to contribute significantly to general economic development.

Economies of Scale in Production of Fluid Milk

Large dairy farms provide economies in the use of farm resources up to the full utilization of each of the individual resources being considered. For instance, the labor resource frequently is fully exploited under present operating conditions when 30 to 35 cows per man are handled, together with replacements and crop production. With some of our newer methods, such as use of herringbone milking parlors and pipeline milkers, it is quite reasonable to expect that farms adopting these improved milking arrangements will report labor intensities of 40 to 50 cows or more per full-time worker.

Studies of farms ranging up to 400 cows per farm-business operation, showed little tendency to increase beyond the average of labor-efficiency level of about 30 cows per man. This means that the farms with 50 to 60 cows and one full-time man—equivalent of labor, or slightly more,

including some family or seasonal help, can attain as high a level of labor intensity as dairy farms with 100 cows or more. Farms with 100 or more cows, however, used capital in the form of buildings and equipment more efficiently than did the 50-cow farms. Yet farms with 50 to 100 cows often do attain relatively high levels of labor and capital efficiency per worker.

Major economies in the utilization of buildings and equipment were obtained at the 100-cow level, although additional economies did occur as size increased to 400 cows per farm. The major advantage of moving to larger size farms beyond the 100-cows size level therefore lies in the increased net return per operator on the farms with the larger number of cows—the increase resulting primarily from larger milk sales and only slightly from reduced average total costs per unit of output. That is, the increased net return results from a



Broiler Shipment Patterns

Optimum corn shipment patterns based upon 1965 consumption estimates with 1.5 cents premium in market areas 1-5 for broilers from producing areas 1, 2, 3, and 8.

larger amount of milk sold at relatively stable profit margins per hundredweight of milk.

On the basis of these data and other observations, there would seem to be few physical operating efficiencies available to increase net returns per hundredweight of milk for most dairymen after a level of 100 cows per herd is attained and fixed labor and capital resources are being fully utilized. In most cases, however, the net farm in-

come to the operator will continue to increase with increased size of herd and volume of milk sales if labor, capital, land, and managerial ability are available and continue to be used at high efficiency. Therefore, it appears likely that Maryland dairymen will continue to increase the size of their businesses in the future to reduce production costs and to increase their total net income from their farm resources.

Project A-18-ar

Trends in Value of Maryland Farm Products Sold

By Districts and by Counties, Census Years, 1944-59

Sales by the farm industry of Maryland expanded in the postwar years from \$137 million in 1944 to \$231 million in 1959, according to the U. S. Census of Agriculture. The increase resulted from greater physical volume of production and from higher farm-products prices.

All livestock and livestock-product sales accounted for 68 percent of total farm sales in 1959, in contrast to 62 per cent in 1944. Decline in sales of vegetables, fruits and nuts accounted for the relative decline in crop sales from 38 to 32 percent in the same period.

In 1959, dairy products accounted for 28 percent, poultry and poultry products for 24 percent and other livestock sales for 16 percent of all Maryland farm-product sales. Crop sales in 1959 consisted of field crops, 22 percent; forest and horticultural specialties, 4 percent; vegetable crops, 4 percent, and fruit and nut sales, 2 percent of all Maryland farm-product sales.

The contributions of the five production districts to the value of farm-product sales in Maryland have changed only slightly during the postwar years. The Piedmont and Lower Shore have maintained a stable share of all Maryland farm product sales,

while the share of Southern Maryland has declined and the shares of the Upper Shore and Western Maryland have increased.

Livestock production and sales were the major source of income in all districts except Southern Maryland, which had crop sales consisting primarily of tobacco, as the major source of farm income. Dairy product sales were the major source of livestock income in the Piedmont, Western Maryland and Upper Shore, while poultry and poultry products were the most important in the Lower Shore district. (See chart on page 6) During the postwar period, all five districts of Maryland showed an increase in the importance of livestock sales, other than dairy and poultry. Sales of poultry products declined in relative importance in all districts except the Lower Shore.

Field crop sales declined relatively in Western Maryland and the Piedmont, but they increased relatively in both the Upper Shore and Lower Shore. Sales of vegetable crops, fruits and nuts declined relatively in each of the five districts. Sales of forest products and horticultural specialties increased in all districts except Western Maryland since 1944.

Project A-18-as

Role of the Northeast in U. S. Farm Production

Farm production in the northeastern part of the United States continued to make a significant contribution to the national farm output during the period from 1950 to 1960, even though the relative share declined slightly. Livestock and livestock product sales accounted for 69 percent of the cash farm receipts in the Northeast in 1960 in contrast to only 55 percent nationally. Sales of crops accounted for 30 percent of the cash farm receipts in the Northeast in 1960 compared with 43 percent nationally. Government payments were responsible for 1 and 2 percent respectively of the Northeast and national cash farm receipts.

Since 1950, Rhode Island, New Hampshire, West Virginia and Massachusetts have shown significant declines in their cash receipts from farming. Pennsylvania, Maryland, Delaware, Vermont and Maine have shown significant increases in cash farm receipts in the same period.

In 1960, New York and Pennsylvania each accounted for approximately one-quarter of the total farm receipts in the region. The three states of New Jersey, Maryland and Maine accounted for approximately another one-fourth of the total farm marketing in the

Northeast. The other seven states in the region accounted for the remaining one-fourth of the cash farm receipts.

Sales of dairy products were the major source of farm receipts during the 1950's, and dairying seems to be in the strongest competitive position for the future. Sales of poultry and poultry products declined relatively in the Northeast during the 1950's and will likely decline relatively in the future; but these products will continue to be more important sources of income than beef cattle, hogs or sheep.

The relative contribution of the Northeast to total United States farm production will most likely continue to decline slightly during the 1960's as additional land, labor and capital resources are withdrawn from the region's farm production and as farm production expands in competitive areas of the country. Adjustments in farm production will continue in the future to meet changing economic conditions as the Northeast becomes even more influenced by urban interests in the utilization of the region's land, labor and capital resources.

Project A-18-as

Dairy Adjustments and Supply Responses in Maryland and the Northeast

Linear programming procedures were used to determine the optimum organization of dairy farms in the ten-county Piedmont region of Maryland, and milk supply response was predicted, based on various prices for the year 1965. Milk prices ranged upward in \$0.20 increments from a low of \$2.80 to a high of \$7.00 on a matrix of farm crop, livestock and accounting activities budgeted on data applicable to

Maryland and the northeastern states in the year 1961.

Two primary solutions were obtained of the milk response on 7 benchmark farms developed from data obtained from 71 farms located in 3 segments randomly selected to represent the 10-county Piedmont area. The first solution permitted benchmark farms to produce, subject to prescribed restrictions, crop yields considered applicable to the

upper 25 per cent of farms. In the second solution, crop yields were maintained at levels average in the area. In both solutions, full use of cropland and permanent pasture land was required. The aggregate supply response of milk to the various price levels is shown in Table 1, which is based on an estimated 3264 farms in 1965.

In the period of 1958 through 1962 wholesale milk prices in Maryland remained within a \$0.05 range of \$4.80 per hundredweight. An examination of wholesale milk prices showed that the price per hundredweight had not been below \$4.40, and had been above \$5.20 in only 3 years, in the period 1946 through 1962. Within this price range, the milk supply response to price change was inelastic as shown in the supply curves on a logarithmic scale in Figure 1. Therefore, a significant expansion of milk supply in the 10-

Table 1 Milk supply response predicted for 10-county Piedmont region in Maryland at two crop yield levels and varying prices

Milk Prices	Crop yields	
	Average	Upper 25%
Dollars	Millions of pounds	
2.80	602.57	635.06
3.40	665.91	659.09
4.00	741.82	911.03
4.40	858.24	950.49
4.60	902.23	1000.55
4.80	902.23	1000.55
5.00	907.02	1034.94
5.20	978.54	1034.94
5.80	1347.25	1442.59
6.40	2060.12	1718.34
7.00	2135.57	2168.72

county Piedmont region of Maryland cannot be expected under the institutional and technological arrangements applicable in the 1961 period and assumed applicable to the year 1965.

Project A-18-au

Aspects of Beef Cattle Production in Maryland

Economic analyses of alternative adjustments on representative beef cattle farms in Maryland revealed opportunities for substantial improvement in net farm incomes. The particular adjustment required and the amount of increased income would depend on the present organization (type of beef system followed) and the quantity and quality of available resources. Representative beef systems analyzed consisted of (1) a cow-calf herd from which 450-pound feeder calves were sold, (2) a cow-calf herd from which 600-pound yearlings were sold, (3) a cow-calf herd from which 1,050-pound slaughter cattle were sold, (4) a feeder enterprise in which 450-pound feeders were purchased and 1,050-pound slaughter cattle were sold, and (5) a feeder enterprise in which 600-pound yearlings were purchased and 1,050-pound slaughter cattle were sold.

Available resources on farms studied consisted of (1) 187 acres of land, (2) 152 acres of plowable land, (3) .87 man equivalent years, and (4) \$58,940 of total capital investment. Data collected from these farmers showed that total cash receipts averaged \$13,743, total cash expenses were \$11,154, and net cash farm income was \$2,589 per farm. In addition to quantity and quality of available resources, the most profitable beef system is affected by the ratio of prices received to prices paid. The relationship between prices paid for feeder cattle and prices received for slaughter cattle in Baltimore, Maryland is shown in the table on page 6.

Linear programming analyses revealed that if certain adjustments were made in the organization and operation of these representative farms, cash receipts would have averaged \$20,128, cash expenses would have averaged \$12,952,

and net cash farm income would have averaged \$7,176 per farm. Thus, earnings of labor and capital would have about doubled. These results were obtained when price relationships were at the 1962 level.

Specific adjustments required to obtain the higher net cash farm income per farm consisted of changes in the cropping system as well as changes in the livestock system. Important adjust-

ments in the cropping system were (1) elimination of small grain and mixed hay, (2) slight reduction in permanent pasture acreage, and (3) increase in the acreage of corn and alfalfa. Adjustments in the livestock system consisted of changing cow-calf herds to purchase of feeder calves at 450 pounds and sale of slaughter cattle.

Project A-18-au

Beef Cattle Prices

Average annual beef cattle prices, Baltimore, Maryland, 1953-63.

Year	Steer price per hundredweight, specified years	
	Choice feeder steers	Choice slaughter steers
1953	\$23.73	\$24.83
1954	\$22.79	\$24.59
1955	\$24.01	\$24.56
1956	\$23.34	\$23.00
1957	\$25.56	\$23.90
1958	\$34.13	\$28.21
1959	\$32.95	\$28.93
1960	\$29.09	\$27.38
1961	\$29.18	\$26.05
1962	\$32.08	\$27.85
1963	\$28.42	\$25.21

Project A-18-au

Estimating the Returns to Inputs of Capital and Labor

Wage rates in an area will normally approach the earnings produced by the last unit of an input used. The returns to the last unit used of an input are called marginal returns, and they can be estimated by various techniques. To this study we used the Cobb-Douglas technique to analyze data taken from records kept by owner-operators of 30 farms in the Bryanstown-Hughesville area of Charles County, Maryland, for the year 1962.

The estimated return to the last tillable acre for farms with 83 acres (geometric mean) of tillable land was \$53.13. Based on 208.2 acres (geometric mean) of total land returns declined to \$5.26. Return to the last

month of available labor—the farms used 26.51 months (geometric mean)—was \$152.27 and \$195.46 when associated with the geometric mean acreage of tillable and total land, respectively.

Returns to investment in machinery and equipment were low, indicating an excess investment in machinery. Earnings on an additional dollar of operating expenses, \$2.40 and \$1.90 for the geometric mean acreage of tillable and total land, respectively.

Equating the marginal returns resulted in an elasticity of production of about 1.25, showing that farmers will attempt to expand. Returns to labor indicate labor will continue to shift

from agriculture at a very rapid rate. The pressure to expand the need to distribute machinery investment over larger operations and low returns to labor is partially compatible with recent trends of rapid abandonment of small tobacco allotments and declining num-

ber of farms. Furthermore, returns to current operating expenses, which are primarily attributable to fertilizer costs, indicate yields of tobacco can be expected to escalate rapidly upward in an effort to maximize returns.

Project A-18-aw

The World's Agricultural Resources

An experiment station miscellaneous publication titled *The Structure of Algerian Socialist Agriculture* which reports on a field survey made possible by the Agricultural Development Council has been released. The analytical framework for research of this type has thus been perfected in a field test. This same framework is being applied again to data gathered in Zambia through another grant from the Agricultural Development Council. The Zambia report will contain an analysis of shifting agriculture as a system of agricultural resource organization.

A progress report on this research

project was presented in the form of a paper delivered to the Workshop in Geography and Agricultural Development, sponsored by the Agricultural Development Council in Davis, California, November 20 and 21, 1964. This paper was titled "Intercultural Comparisons of the Structure of Systems of Agricultural Resource Organization."

Publications resulting from this project should prove useful to any agricultural economist who is getting ready for his first cross-cultural experience either as a student or as a technical assistance worker. *Project A-18-ax*

Profitability of Alternative Feed Handling Systems

Time and motion techniques were used on twelve Maryland dairy farms to obtain the time and labor requirements for feeding and milking. These farms ranged in size of herd from 25 to 200 cows. The initial visits were started September 1, 1963. A total of 6 visits to each of the 12 farms was made during the period ending September 30, 1964.

The average daily time per cow spent on feeding and milking operations was 4.08 man-minutes. Milking operations required an average of 3.03 man-minutes per cow each day; and the feeding operations took an average of 1.05 man-minutes per cow.

These farms had an average of 78 cows each. Two men per farm, on the average, did the milking. These

workers handled an average of 3 machines and milked an average of 39 cows per man. The average daily milk production was 36.5 pounds per cow.

Average daily time required for feeding forage and concentrates varied widely from farm to farm and by type of forage fed and system of feeding. The total minutes required were greatest for green chop, followed by silage, then hay, and finally concentrates.

The results of this study can provide a basis for decisions by dairymen to improve their business efficiency and profitability through a reduction in labor costs, increased production, or a combination of both.

Project A-18-ay (NE-43R)

Silage Costs on Northeastern Dairy Farms

Silage costs vary widely among dairy farms throughout the Northeast. However, average silage production costs up to harvest show a considerable degree of uniformity among the states of Delaware, Maryland and New Jersey, as well as in other states in the Northeast. Average total costs per acre for producing corn silage up to harvest were \$72 in Delaware, \$73 in Maryland and \$77 in New Jersey. Average variable costs per acre were \$22, \$24 and \$25 for Delaware, Maryland and New Jersey, respectively. Similar production-cost data from New Jersey showed average total costs per acre of \$59 for soybean-sorghum silage and \$40 per acre for grass silage.

Average harvest costs for corn silage of \$17 and \$29 per acre and \$1.29 and \$2.29 per ton were reported for Delaware and New Jersey, respectively. New Jersey reported average harvest costs of \$31 per acre and \$3.57 per ton for grass silage and \$36 per acre and \$2.59 per ton for soybean-sorghum silage.

The most common silage harvest pattern was a three-man crew with three tractors, a forage chopper and two self-unloading wagons. A silo filler was also required when filling a tower silo. A number of farms had two trucks for hauling silage, instead of two tractors and two wagons.

Total initial costs increase as the storage capacity and size of silo increase for each of the four types of silos considered. However, the average initial investment per ton of rated storage capacity declines at a decreasing rate as the size of the silo increases. Two variables, width and height, operate to cause this decrease cost per ton as the size of silo increases. Increased width of tower silos causes cost per ton

of rated capacity to drop sharply. A somewhat smaller cost reducing effect is caused by increased height of tower silos.

At any given size or capacity of silo, the initial costs are lowest for trench silos with earth floors and earth walls. The bunker silos with concrete floors and wooden walls, the concrete-stave tower silos and the glass-lined steel tower silos have higher initial costs at any given capacity than the unlined trenches. At the 506-ton capacity, the initial costs are \$24.30, \$14.40, \$5.20 and \$0.25 per ton, respectively, for glass-lined steel, concrete-stave, bunker, and unlined trench silos.

In general, horizontal silos have higher spoilage losses than tower silos. Therefore, low valuations on silage spoilage losses will make the horizontal silos relatively more attractive than tower silos as low-cost methods of storage. Likewise, high valuations put on silage spoilage will make tower silos more attractive in terms of cost as a means of storing silage.

The unlined trenches can provide cheaper storage than the tower silos even if spoilage losses amount to 10 percent of the total silage stored and are valued at \$9 per ton of silage. The cost per ton of storing silage also is lower for bunker silos up to 350 tons of capacity. The concrete stave tower silo become a cheaper means of storage after this quantity.

The larger silos have a definite cost advantage over smaller silos within any type of silo groups considered. Large silos not only lower initial and annual costs per ton of capacity, but they also have lower labor requirements per ton of silage.

Project A-18-ay (NE-43)

Market for Farmland

Number of Transfers, Acres Transferred, Average Size of Tracts, Average Price Per Tract and Per Acre, by County, for Six Maryland Counties in 1962.

County	Number of transfers	Acres transferred	Average size of tract (acres)	Total consideration	Average price per tract	Average price per acre
Frederick	289	17,554	60	\$ 4,615,908	\$15,972	\$ 262
Harford	191	8,056	42	3,306,974	17,314	625
Prince George's	328	10,431	31	19,242,120	58,665	1,844
Queen Anne's	87	7,893	90	1,814,124	20,852	229
St. Mary's	99	3,801	38	1,386,792	14,008	364
Somerset	109	8,551	78	979,692	8,988	114
Total or Average	1,103	56,286	51	\$31,345,610	\$28,418	\$ 557

Transfer of Farm Real Estate in 6 Counties in 1962

This project was undertaken to provide desired information concerning the market for farm and open country real estate in Maryland. More specifically to determine the number of transfers, the size of the tracts being transferred, the changes in land use, and some of the characteristics of the individuals involved in the Maryland land market.

It is very desirable that we know the characteristics of the market for this resource, since land is agriculture's primary resource base and approximately 4½ percent of the farmland in Maryland is transferred to new ownership each year.

The data for this study was collected with the cooperation of the county assessment offices and by the use of mail questionnaires to the buyers of the tracts. This material has been coded and a primary analysis is underway. Although no final tabulations are available at this time it is evident that

there are significant variations between the areas studied. Some of the variations appear to be closely related to the rate of population growth in the specific areas and with the location or geographical feature of a particular county. There appears to be considerable speculation taking place within a few of the areas and this may be a major factor affecting land prices.

The preliminary analysis indicates that the individual purchases for rural residences and purchases for housing developments are probably highly significant in the Maryland land market. Purchases for farm enlargement made up only a small percent of the total transactions.

Interestingly, the preliminary analysis indicates that approximately 70 percent of the buyers in these 6 counties were non-farmers; of this 70 percent, approximately half were either white-collar or professional workers.

Project A-18-a2

New Approaches to Farmland Tax Assessments Appear on Horizon

Maryland's farmland tax assessment law was the first of its kind in the Nation. It specifies agricultural-use values, rather than subdivision or other use values, as the basis for farmland taxation. Since its enactment in 1956, many problems have risen in connection with its application.

An early problem, not yet fully resolved, was that of identifying land actively devoted to agricultural use. Another problem relates to those factors which together determine values of different farmland classes for tax purposes.

Under the Maryland law, market price or cash value of farmland is valid only when it is about the same

as agricultural-use value for tax assessment purposes. In counties near large urban centers, market prices of farmland are, in general, much above agricultural-use values. This means that two concepts of value must be kept in mind when assessing farm real estate: (1) The value of land based on agricultural use; and (2) the value of buildings based on market price or cash sale value. Obviously, even tax assessors have difficulty in keeping these concepts separated.

These mixed concepts, or bases, in assessing farm real estate often result in awkward situations for assessors to resolve. They also set the stage for tax avoidance by speculators who hold

agricultural land for higher use values while being protected against assessments by making nominal farm use of such land.

There is need for determining those conditions or factors responsible for variations in farmland use values. This deficiency in the assessment procedure has stimulated consideration of the possible use of data about soils, crop yields, and capitalization of farm income or rent from farmland in arriving at assessed values.

Since the soil factor is generally related to crop production, it seems that knowledge of the potentials, or productive levels, of different soils should be useful as a beginning step in assessing land. In fact, officials responsible for property tax assessment values are actively exploring the practical application of soil data in the assessing process. This is of special significance in Maryland and other states where market prices or cash values are not neces-

sarily the legal basis for assessing farmland. Moreover, a knowledge of farm management, as it affects economic return from land, is of equal importance.

To this end it seems desirable for the State Department of Assessments and Taxation to employ, on a temporary basis, a soil scientist to interpret soil data and develop guidelines for use in assessment work. Likewise, a farm management and finance specialist can serve effectively in arriving at farmland values based on soil variations and other factors which influence such values.

Improvements in the facilities of many county assessors' offices seem desirable. Duties of these offices could be more uniformly defined. It would then be proper to consider county and state sharing of other assessment office expenses, as in the case of assessors' minimum salaries.

Project A-19-z

Labor Flexibility Essential to Milk Plant Efficiency

A work sampling (ratio-delay) study of a large milk manufacturing plant shows that labor flexibility, in movement and skills, is essential to efficient operation in the processing of milk into manufactured dairy products. In the short run (less than 1 year) plant management has practically no control over plant size, or the seasonal flow of raw milk coming to the plant. Furthermore, the number of employees needed at each station is relatively fixed. However, although most of the stations where labor is needed are used each day, only part of the stations are in use at any given time.

Management's principal, if not exclusive, opportunity for improving labor efficiency therefore is concerned with the possibility of rapidly shifting

the manpower of the plant to stations where the greatest volume of milk is moving. This requires, first, that a substantial number of the total plant employees are trained to perform the functions required at several different stations in the plant; second, the management carefully plan each day's activities in order to maximize the movement of workers rapidly from one station to another as the milk flow proceeds from the receiving room to the final product.

Promising long-run procedures which could improve plant and labor efficiency include merchandising designed to increase the sale of certain products from plant areas which were rarely used during the period of study.

The work-sampling study clearly in-

licated the importance of the foregoing adjustments by showing that the proportion of worker's time productively employed in the plant from March to September, 1962, was under 65 percent on 5 of the 13 stations, and exceeded 80 percent by a slight margin on only 2 stations. Equipment and utilization i. e., the percentage of time

equipment was being operated, was even less, ranging from less than 18 percent on three stations, and in excess of 85 percent on only one. Labor was productively utilized, on the average, on 68 percent of all stations; but less than 32 percent of equipment was productively used.

Project A-26-bc: (NEM-25)

Impact of Economic Investments on Marketing and Payrolls

Hypotheses were developed to analyze, test and measure the impact of economic investments which occurred in the State of Maryland during the most recent 10-year period. For a detailed study, 4 counties were randomly selected from a universe of 18 counties, not surrounding the large metropolitan areas. Harford and Kent Counties

were chosen to represent high-growth areas; Washington and Dorchester Counties to depict low-growth counties. The basis for the sample selection was the annual growth in taxable payroll for the January-March quarters during the years for which data were available (table 1.)

Table 1 Average annual growth rate in the taxable payroll for the January-March quarters of 1953, 1956, 1959, 1962

Counties	Percent	Counties	Percent
1. Harford	14.0	1. Calvert	7.0
2. Kent	11.2	2. Dorchester	6.4
3. Queen Anne's	10.0	3. Worcester	5.9
4. Talbot	9.6	4. Allegany	5.9
5. St. Mary's	9.4	5. Frederick	5.0
6. Carroll	9.2	6. Caroline	3.7
7. Garrett	9.1	7. Charles	3.5
8. Wicomico	7.8	8. Washington	2.1
9. Cecil	7.6	9. Somerset	1.4

Source: County Business Patterns, U. S. Bureau of Census.

Tentative findings suggest that the populace in the high-growth counties tended to possess higher levels of in-

come and education than the people residing in the low-growth areas.

Project A-19-a

U. S. Private Investment in Food Processing Plants in Latin America

This project, initiated in fiscal year 1963-64, deals with the barriers to U. S. private foreign investment in food processing plants in Latin America. General investment data on the extent of U. S. private foreign investment in Latin America were collected from several sources. The general data sources included the U. S. Dept. of

Commerce, U. S. Department of Agriculture, Inter-American Development Bank, Pan American Union, embassies of Latin American countries located in Washington and Latin American Trade Associations located in New York City. Data on specific investment by United States firms were obtained through questionnaires mailed to the

firms known to have invested in Latin America. The questionnaires asked for information on the history, type of product, location and volume of the companies' plants in Latin America.

At the end of fiscal 1963-64 the project leader and his assistant commenced a nine-week survey of American investors in Latin America. This study

covered eleven countries and resulted in the collection of much data through interviews with U. S. Embassy and AID personnel, U. S. private firms investing abroad, American banks, as well as government and bank officials of the Latin American countries themselves. The findings of this study will be published.

Project A-19-AB

Adjustments in Broiler Industry in Relation to Area Competition and Market Demand

This study was concerned with the proposed reductions in freight rates recently effected, or in the process of litigation, that affect the Maryland broiler industry.

Important proposals analyzed herein were: (1) A proposal by the Southern Railway (2) A reduction in rate on rail shipments of corn originating in Ohio and shipped to Delmarva, (3) A reduction in the arbitrary rate over Baltimore. Finally, proposals for freight rate reductions were analyzed in terms of their economic impact on the Maryland broiler industry.

The Southern Railway proposal, initiated in 1961, provided for a reduction of approximately 60% for grain moving in the Southern Railway territory. Subsequently this proposal resulted in hearings conducted by the Interstate Commerce Commission and litigations in the courts. For purposes of this report, documents presented in hearings were reviewed and discussions were held with the transportation authorities participating in the case. Similar procedures were followed in

analyzing other freight rate proposals which could have an impact on the Maryland broiler industry.

This report contains the essential elements of various proposals made, the evidence presented, and certain rate compilations, showing the before-and-after consequences of the rate changes.

The impact these rate changes would have on the Maryland broiler industry was viewed from the standpoint of Maryland's competitive position with other major broiler areas in the U. S., both with respect to prices of feed ingredients and to transportation rates on final products.

Specific objectives of the study were: (1) to present the various proposals made for freight rate reductions; (2) to analyze the testimony presented at the Interstate Commerce Commission hearings as a basis for determining possible impact on the Maryland broiler industry; and (3) to report the present state of litigation and appropriate freight rates in effect at the time of the report.¹

Project A-26-bd

¹Harold Smith and Earl Miller, "Economic Analysis and Status of Freight Rate Proposals Affecting the Maryland Broiler Industry," (in process).

Maryland Tobacco Industry Has Little Control Over Major Export Use of Maryland Tobacco Leaf

A combination domestic packing plant and foreign utilization study of Maryland export tobacco leaf which is currently nearing completion indicated that: Unpredictable and sporadic arrivals of tobacco from the auction warehouses to the packing plant is the major factor contributing to substantial amount of wasted labor at almost all stations where people are employed moving tobacco from the trucks to the final packed hoghead. As a result, the stations tend to experience periodic gluts and shortages of tobacco during the day; and productive worktime, allowing for needed personal rest periods, some 15 percent for each employee, averaged less than 50 percent during the packing season. Although the analysis is not yet complete, indications are, that since management has little control over the number of loaded trucks arriving at the same time during the day, it is very difficult to make meaningful and consistently worthwhile adjustments for more efficiency in the use of plant labor.

Investigation of the utilization of Maryland tobacco leaf by foreign importers indicated that the Swiss market is of major importance to the Mary-

land industry, since it takes more than 90 percent of total annual exports and requires the highest quality of Maryland tobacco leaf. Therefore recent trends toward a rapidly increasing consumption of the American blend brands of cigarettes produced by Swiss cigarette manufacturers under contract with the American copyright owner, and an even more recent expansion in the manufacture of "European blend" brands of cigarettes, might prove to be inimical to the Maryland tobacco industry by shifting tobacco utilization in Switzerland away from Maryland leaf toward the burley flue-cured, and oriental leaf more commonly used in blended cigarettes. The trend toward consumption of American blend brands is particularly important because these cigarettes are now being manufactured by the same firms that also manufacture "Maryland brands" which have been utilizing 85 percent or more of Maryland tobacco leaf.

Thus far the Maryland brand still exceeds all others in total consumption, but the proportion of Maryland brands among all cigarettes consumed in Switzerland have declined in the last decade. *Project AE-26-bf (ES-699)*

Changes in Northeast Processed Vegetable Industry

Structural changes pointing to concentration and centralization of the vegetable-processing industry have become evident in Maryland. In order to gain a deeper insight into the underlying causes of these changes, two approaches were taken.

The first was to study vegetable processing firms which had recently gone out of business to learn the reasons for the firms' demise. A list of factors associated with the termination of processing firms in Maryland has been developed. However, comparisons with

firms still active in the processing industry showed that a number of these factors existed in the active as well as the terminated firms.

The second approach was to take a broad look at the structure of the Maryland processed-vegetable industry and to search for explanations of the shifts. Analysis of pertinent data suggests that valid explanations for these structural changes are available for use in future planning by vegetable processing firms.

Project A-26-bj (NEM-29)

Changing Structure and Performance of the Northeastern Grain-Marketing Industry, 1957-62

Ten percent less whole grain was marketed in the Northeast in 1962 than in 1957. Export volumes dropped from 183 million bushels in 1957 to 91 million bushels in 1962. Domestically, 20 percent less whole grain was channeled into northeastern feed-manufacturing plants. This decline in business caused serious problems to members of the grain industry within the region. Many establishments were forced to close. The number of establishments of the major segments of the northeastern grain industry changed as follows:

Industry Segment	1957	1962
Terminal elevator	35	27
Flour milling	112	92
Feed manufacturing	516	412
Country elevator	86	76
Retail outlet	1,030	922
Total	1,779	1,529

Based on estimates of profitable operations, only about two-thirds of the terminal elevators were operating above minimal standards in 1962. Integration with other grain interests outside the region appeared to be the key to profitable operations.

A preponderance of the establishments egressing from the industry were independent organizations. As the number of establishments declined control of the industry became more concentrated. In the case of feed manufactur-

ing, more and more trade areas may be served by only one establishment in the near future.

The performance of the regional marketing system was plagued with both unused and excess capacity. Excess capacity existed in terminal elevator, feed manufacturing, country elevator, and retail outlet segments of the industry. Suburbanization, competition from other U. S. ports, and a decrease in grain-consuming animal units contributed to excess capacities. A lack of real grain interests (those of a decision-making nature) appeared to result in unused capacities in this grain-deficit region.

Changes toward fewer numbers and increasing integration with grain interests outside the Northeast reflected structural adjustments conforming to changes in U. S. export channels, suburbanization, and decreases in grain-consuming animal units. Changes, such as these, should lead to an improved performance of the grain marketing system so long as the volume of business continues to decline and so long as the egression of establishments is based solely on a necessitated reduction, rather than because of unwarranted growth of a few.

Project A-26-61

The Export Market for Maryland Agricultural Products

In 1964 research was completed on the export market for nonfat dry milk solids; and research was initiated on the implications of the European Common Market for Maryland Agriculture.

In the research of nonfat dry milk solids past, present, and projected fu-

ture trade patterns were examined particularly as they are affected by export programs in the major exporting countries. It was recommended that the United States consider using a multiple-pricing scheme (price discrimination) similar to one currently being used to

a limited degree by New Zealand. Such a plan it is believed would increase returns on its nonfat dry milk exports. This in turn would lower the cost of the present surplus-disposal program and take pressure off dairy-support

prices. Since the scheme discriminates in favor of low-income countries it would also tend to increase sales and thus nutritional levels in these areas, the ones needing it most.

Project A-26-bm

Use of Lag Models in Estimation of Long-Run and Short-Run Elasticities

Empirically derived demand elasticities play important roles in agricultural policy considerations. For example, estimates of the impacts and responses to changes in price support levels require the use of these elasticity estimates. Therefore, in order to evaluate alternative policy considerations it is important that accurate elasticity estimates be used.

This study investigates the effects of, and suggests the possibility for reducing, two types of bias in empirical demand studies employing lag models. Demand elasticity estimates for selected agricultural commodities have been derived under more general economic and

statistical assumptions than are usually employed in conventional lag models.

It was found that when annual data were used to derive elasticity estimates the long-run price elasticities were more seriously biased. However, when monthly data were used, the short-run income elasticities were the more seriously biased.

A computer program was developed for this project, which permits the derivation of elasticity estimates: (1) less biased and (2) that result in demand relationships which give better adjustments to empirical data.

Project A-26-bn

Processing Efficiency and Costs in Broiler-Processing Plants

This study is concerned with broiler-processing costs on the Delmarva Peninsula, so that processors can reduce these costs where possible.

Some specific objectives include: (1) to analyze the causes for differences in processing efficiency and costs between and within poultry processing plants in Maryland (2) to determine plant costs, as well as labor input and output coefficients, and (3) to analyze the competitive position of plants operating in the Delmarva Peninsula.

A case approach is being used to study each plant, and then the plants will be grouped so that a firm may compare its own position. Model plants will be synthesized in order to hold some factors constant to measure the effect of certain variables. Also, Delmarva costs will be compared with those of competing broiler areas.

A-26-bo

AGRICULTURAL EXTENSION EDUCATION

Research in the Department of Agricultural and Extension Education is devoted to gaining knowledge that will improve the effectiveness of programs of educating present and potential workers in the field of agriculture.

Attention is also directed to understanding the social problems that face the agricultural sector of the economy and to gain knowledge that will lead to solutions of these problems.

Teaching Reading to Pupils in Agriculture

High school pupils enrolled in agriculture represent a broad range of ability and experience. Although some of the pupils are among the top achievers in their schools, many of them, especially in small rural high schools, come from homes where educational and cultural experiences are inadequate.

A study underway in Maryland appears to show that pupils enrolled in agriculture classes do not read as well as their classmates not so enrolled. This handicap is seriously retarding their learning. It is assumed that these pupils,

because of their special interest in agriculture, would be more likely to improve their reading ability if given reading-improvement instruction and training with agricultural subject-matter materials rather than with literature or other matter in which they might have less interest. In cooperation with the Reading Clinic of the University of Maryland, an experiment is in progress to test the effectiveness of integrating a reading-improvement program into regular instruction in Maryland high school agriculture classes.

Project T-10

The Farmer's Mechanical Skills

Adult and young farmers generally agree that growing mechanization of farms has reached the point where successful operation requires training and ability to use, maintain, and repair machinery and equipment.

Operations of selected farmers to report to vocational agriculture teachers indicated that the numerous needed

skills included among others, those of adjusting and repairing tires on farm machinery, sharpening field mower knives, calibration of sprayers, repairing metal roofs, splicing woven-wire fences, and adjusting the running speed of combines by use of a tachometer.

T-11

AGRICULTURAL ENGINEERING

Application of engineering in agriculture promotes production, harvesting, transportation, processing and marketing of plant and animal products and the conservation of natural resources. These functions are accomplished through the application of energy to transform the crops or products or to change the environment in which these are, stored, processed, grown or marketed.

In cooperation with scientists of other disciplines, engineers seek to determine the essential environment for biological processes and the changes in products necessary to enable their use. The engineering task is then to seek the most efficient design for application of the energy necessary for management of biological systems.

It is not possible to undertake all engineering aspects of biological systems in a single department. Each department can contribute to the whole cloth of agricultural engineering research through cooperation. The work summarized here includes two projects (R-16 and R-20) which are specifically contributing to regional research plans and also two studies of regional and national importance, which are made in cooperation with the Agricultural Engineering Research Division, Agricultural Research Service, of the U. S. Department of Agriculture.

Environmental Requirements of Poultry

Three trials were made in the constant-environmental pens. Different brooding temperatures and different rates of weekly reductions of these temperatures were the variables studied. Birds used in this test were White Rock cockerels, which were not vaccinated against any disease but had been pronounced free of PPLO. A pelletized commercial broiler ration containing a coccidiostat was used.

Starting temperatures for different lots of 100 chicks were 95°, 90°, and 85° F plus a 250-watt infrared heat lamp; also 70° plus the same size heat lamp. Rates of temperature reduction studied were 5° F per week, 10° per week in two 5° steps and 1° F per day starting on the 2nd day. Relative humidity was held constant at 60° F for

the entire test. When 60° was reached the temperature was held constant at this point for the remainder of the test. The 70° F starting temperature was held constant for the entire 8 weeks and the heat lamp was removed after the 5th week. A summary of the results from these trials is given in Table 1.

For the 5° F per week temperature reduction the 90° starting temperature produced the heaviest average weight bird, 4.86 pounds. With the 85° F starting temperature the final average weight was only 0.04 pounds lower. It should be noted that the standard or recommended starting temperature of 95° F was the lowest in average final weight.

Observation during brooding showed that the birds started at 85° plus a heat

Summary of data for test on brooding temperatures

Treatment	1 ³	2 ⁴	3 ⁴	4 ³	5	6	7	8
Starting temperature	95°	90°	85°	85° + 1	90°	85°	85°	70° + lamp
Reduction in Temperature	5°/wk.	5°/wk.	5°/wk.	5°/wk.	10°/wk.	10°/wk.	1°/day	continuous
Average 8 wk. wt.	4.66	4.86	4.82	4.70	4.78	4.83	4.57	4.77
Cumulative feed efficiency	1.92	1.97	2.03	1.99	2.04	2.02	1.98	2.00
Individual maximum wt., lbs.	5.56	5.79	5.97	5.80	5.36	5.48	5.20	5.62
Individual minimum wt., lbs.	3.57	3.80	3.73	3.31	3.60	3.79	3.76	3.64
Lbs. water/lb. gain	3.28	3.43	3.95	3.97	3.75	3.58	3.74	3.64
Lbs. water/lb. feed	1.58	1.64	1.86	1.48	1.73	1.70	1.77	1.61
Average pigment score ¹	4.44	4.19	4.39	4.51	4.24	3.98	4.31	3.41
Average feathering score ²	1.81	1.93	1.88	1.59	2.44	2.19	1.91	1.57
Cumulative mortality % (5 wk. age)	4.85	4.87	4.56	5.27	6.87	7.93	5.89	1.96

¹ Scored from 1 to 6; with 6 being deepest color.

² Scored from 1 to 3; 1 being best.

³ Average of 2 tests conducted under these conditions

⁴ Average of 3 tests conducted under these conditions.

lamp did not huddle under the lamp and seemed to avoid being directly in the heat zone. It is believed that at this temperature and humidity condition the lamp is not needed and the birds did much better under the same condition without a lamp. However, for the 70° constant conditions the chicks did stay under or near the lamp.

There was no significant difference in final weight, mortality, feathering score and pigment score among the pens started at different temperatures and reduced 5° per week. There was little variation among birds within pens.

For the tests in which the temperature was reduced 10° per week in two steps the 85° starting temperature gave the heaviest average weight birds (4.83 pounds). However, for the same rate of reduction starting at 90° F the weight was only 0.05 pound lower. The mortality was higher for the 10° per week reduction than for the 5° per week.

There was no outstanding difference in any of the tests in feathering scores, pigment scores and feed efficiencies.

Project M-1

Tobacco Housing

The tobacco cured in the compact-curing facility during the 1963 season was sold on the auction market with the 1st cure, averaging \$68.00 per 100 lbs and the second cure averaging \$65.00 per hundred. The net auction sales for the 1963 crop averaged \$42.73 per hundred. The grades placed on this tobacco at auction by Government graders indicated top-quality tobacco.

Chemical analysis was made of this tobacco for total nitrogen, protein nitrogen and percent total alkaloids. Analysis for nornicotine has not been completed. In general, the chemical composition of the compact-cured compared favorably with the barn cured. There was an indication that the protein, as percent of the total nitrogen, was higher for the compact tobacco, which should produce a better smoke.

During the 1964 season minor improvements and modifications were made to the compact-curing facility. The curing procedure was to operate the fan only during the day. During

fan operation the temperature was controlled between 80° and 90° F by a thermostat. Preliminary evaluation indicated a very good cure.

Project RB-11-g



Compact curing facility showing green tobacco hung at a density of seven plants per square foot of floor area; air is forced through the tobacco at a rate of approximately 8 cfm per plant.



Stick of tobacco cured in the compact curing facility.

Pneumatic Handling of Chopped Forage

The study of the transportation characteristics of semidry chopped hay in a horizontal pipe was continued with the field system. In addition, a major effort was directed toward the design and development of a laboratory system to complement the field studies.

The laboratory system consists of a horizontal belt conveyor to feed material uniformly into a rotary air-lock. The rotary air-lock, 15 $\frac{3}{8}$ -inches in diameter and 12 inches long feeds the material into the air stream. The delivery or transport pipe consists of fifty feet of 6 $\frac{3}{4}$ inch plexiglass pipe in a horizontal position.

Micro-differential pressure transducers were developed, using linear differential transformers for instantaneous

recording of air pressure in the pipe. For the first time, it was possible to obtain a continuous record of the static pressure within the transport pipe during a test.

Tests were completed with the 9 $\frac{1}{4}$ -inch pipe and design curves showing relationships for pressure drop in 50 feet of pipe as a function of conveying air velocity for different material rates were determined. A 12-inch pipe was installed and tests were made with material ranging from directly chopped to material that had dried to 35% moisture. Results indicated that the material moisture content had little influence on the pressure drop for a given initial air velocity.

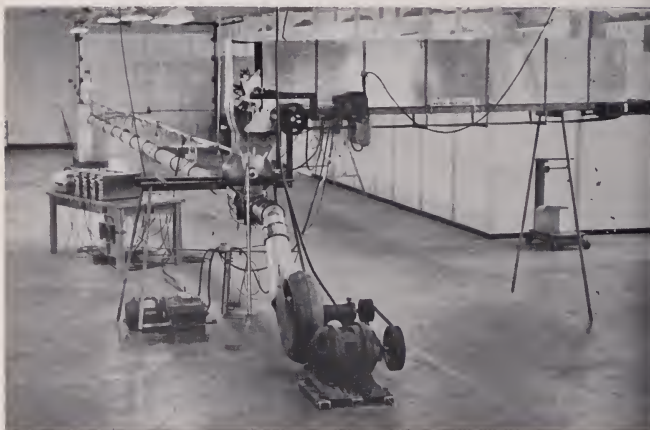
The performance of the rotary air-

lock was unsatisfactory as a metering device for chopped forage.

In the design of a pneumatic conveying system for chopped forage, knowledge is needed of the pressure drop for a given pipe size as a function of the conveying air velocity at different material rates. The data obtained contributes to the information needed by the design engineer.

Project R-16

Micro-differential pressure transducer used to measure static pressure within transport pipe of pneumatic conveying systems.



Laboratory system developed for conveying chopped forage by a high-velocity stream of air.

Equipment and Improved Methods for Sweet Potatoes

Concave disk coulters were found to be less effective than flat coulters for cutting sweet potato vines. The concave disks also increased the problem of the soil entering the elevator when the disks were turned to throw the soil either in or out.

At a ground speed of 2 miles per

hour, soil moved over the digger blade and up the elevator more smoothly than at 1 mile per hour in both dry and wet soil. Injury to the potatoes was slightly higher at the higher ground speed.

Project R-18

Separating Crop From the Soil in Harvesting Root Crops

The effect of changing the relation of digger-chain speed to ground speed was measured in harvesting Irish potatoes. In wet, light sandy soil the force required to pull the machine decreased as the ratio of digger speed chain to ground speed was changed from 80% to 100% to 130% and increased when it was changed to 150%, with very little effect due to ground speed in the range of 2 to 4 miles per hour.

In damp heavy soil, the force required to pull the machine remained substantially constant as the chain to ground speed ratio was changed from 80% to 100% to 130% and decreased when it was changed to 150%, again with little effect due to ground speed.

Sweet potatoes were injured less with $\frac{3}{4}$ " displacement of the shaker bed than with $\frac{1}{4}$ "; and was less with displacement of $\frac{1}{4}$ " than with $1\frac{1}{4}$ " when operated at the same design acceleration. Injury to sweet potatoes was greater at high frequency (high design

acceleration) at all displacements and ground speeds at low displacements. Injury was reduced by reducing ground speed to low frequency. This relation was not true at high frequency.

A machine was constructed to determine the angle at which potatoes roll on digger chain operated at various speeds without soil. On conventional digger chain, carried on conventional 4" diameter rollers, potatoes were found to roll slightly even at 15 degrees from the horizontal at 1, 2 and 3 miles per hour chain speed; at 30 degrees, rolling down grade was severe. If the same chain was carried on slides, potatoes did not roll below an angle of 25 degrees at 1 mile per hour and below 20 degrees at 2 and 3 miles per hour. Rolling was much more a problem with straight bar chain than with chain where alternate bars were bent up and down.

Project R-20

Construction of Specialized Equipment for Agricultural Research

A harvester for small plots of forage was designed and constructed. It is of the flail type and will cut a 16" strip from the center of a 21" plot. Harvested material is collected in a basket.

Irrigation equipment also was designed and constructed for small forage plots.

Project R-21

Farmstead Water Requirements

Farmstead water use was recorded on five Maryland farms. The data collected have limited direct value because, in most cases, peak demand was limited by the water system rather than the requirements of the user. A method of approximating the desirable peak capacity of dairy farmstead water systems was developed, based upon analysis of water use data and labor efficiency.

Significant progress was made in the development of design criteria to overcome the limitations imposed on individual water systems by low-yielding wells. Two water systems were installed using these criteria. The results indicate that these criteria can minimize initial and operating costs for farmstead water systems.

The basic theory and principles of an automatic livestock waste removal system were developed. Basic project

requirements have not given as much time to be devoted to this system as its potential indicates that it deserves.

Hydraulic waste removal and cleaning of livestock facilities with a booster pump to increase pressure at the nozzle has produced time savings of 20 minutes to 1 hour per day on farms. In some cases there is also a definite saving of water. In others, a more thorough and complete cleaning job is obtained because of the ease with which it may be accomplished; the additional cleaning makes it difficult to evaluate the effect upon total water use. At present, 10 gpm at 70-80 psi appears to be the desirable flow-pressure combination for areas under 5000 square feet.

Hydraulic waste removal for areas over 5000 sq. ft. has not been studied because of equipment requirements.

Cooperative Project with USDA

Farmstead Waste Disposal

Water pollution is of growing concern and recognition both from health and esthetic points of view. Farm waste disposal is also growing in magnitude and already is critical in many areas.

One partial solution to the waste disposal problem is the manure disposal lagoon. When properly designed the "lagoon" will biologically stabilize animal waste quite satisfactorily. However, where there is an effluent from these lagoons which discharges into public waterways the plant nutrients in the effluent promote the growth of algae and other aquatic plants. These in turn can (in an oversimplification) contribute to stream pollution.

Work this year has centered on the

feasibility of removing these plant nutrients from lagoon effluents by hydroponics. In a further attempt to make the process economically practical it was decided to attempt to produce a hay or silage crop by this method at the same time.

Results of the feasibility test show that under laboratory conditions it is possible to remove as much as 82% of the dissolved solids (nutrients) in the effluent and to produce a "green cut" from at least one species of grass (*panicum agrostoides*) of the equivalent of 80 tons per acre-inch of lagoon effluent.

*Cooperative Project with USDA
Project R-22*

AGRONOMY

The research program in the Department of Agronomy is directed toward development of improved crop varieties and improved soil and crop management practices that result in more efficient crop production. The size and importance of the program is emphasized by the many crops (corn, soybeans, small grain, tobacco, turf grasses, hay and pasture crops) and the wide range of soils found in the state. The soils and crops research work is conducted in the greenhouses and laboratories at the University, on the University Experimental Farms and on the farms of cooperating growers throughout the state.

The following reports give the scope of the research work in progress:

Breeding of Improved Varieties of Forage Species Adapted to the Northeast

An experiment with two cutting regimes imposed upon nine alfalfa synthetics entered its third season. Results indicate that the severe cutting schedule (May 19, June 23, July 28, and September 1) did not produce any more significant hay yields than the moderate cutting schedule (June 3, July 18, and September 1). In the northern states of the northeastern region, however, the hay production was slightly greater from the moderate 3-cutting schedule than from the severe 4-cutting schedule. The severe cutting schedule also resulted in stand reductions of 11 to 27 percent from the moderate cutting schedule.

A bromegrass experiment which compared eight experimental synthetics with two check varieties was concluded. Included were the first and second generations of the synthetics, two cutting managements, and bromegrass in asso-

ciation with alfalfa. The early generation (Syn 1) was not significantly different in hay yield from the second generation (Syn 2) in any of the experimental synthetics. The first cutting made at time of flowering produced more hay than when the first cutting was made 3 weeks before flowering. Production of hay was greater when the bromegrass synthetics were seeded with alfalfa. Cutting the bromegrass synthetics 3 weeks before flowering also tended to reduce the stands. In general, persistence was better among the new synthetics than in the two check varieties Lincoln and Saratoga.

Harvesting orchardgrass synthetics 2 weeks before flowering did not appreciably change yields or stands, as compared to harvesting at time of flowering.

Project B-56-i

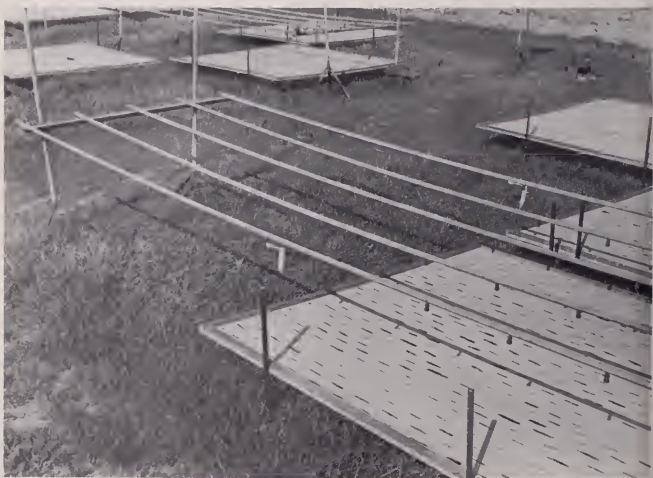
Controlled Climate Leads to Understanding of Plant Growth

The production and nutritive value of forage crops are markedly influenced by the environment in which they are growing. Attempts to measure the effects of climate are under way in growth-control chamber studies. The complexity of weather conditions makes it extremely difficult to duplicate actual field environment in the laboratory. For this reason equipment has been installed in the field to study the effects of soil temperature, light and moisture as they effect the performance of forage crops differentially fertilized and managed.

The equipment was operated for the first time during the 1964 growing

season. Soil temperatures used were 50°, 70°, and 90° F. There was a marked temperature response, with the 70° plots being the most productive, followed by the check, 50° and then 90° plots. Low light intensity along with the high temperatures, high nitrogen fertilization and low stubble harvesting caused most severe stand losses. It was comparatively easy to maintain soil temperatures at 50° and 70° F even during the hot summer days, but it was difficult to maintain 90° soil temperatures during late September and October and even during cool summer nights.

Project B-73



Plant climate experimental area used to evaluate the performance of forage species where soil temperature, light and moisture are controlled.

Late Planting and Winter Survival in Oats

Winter oats planted too late to permit complete emergence in a cold, dry seedbed may still develop enough winter hardiness to survive a mild winter in central Maryland. The seven test varieties previously used in this project were field planted in 1963 on October 3, October 10, and October 21. A rainless October resulted in a dry seedbed, especially for the last planting, for which initial stands were limited to a

range of 37-68% perfect. Initial stands, however, came through the winter with survival as follows: 1st planting, 100%; 2nd planting, 93-100%; and 3rd planting, 82-87% for the seven varieties. Laboratory freeze tests for plants grown in flats alongside the nursery (and irrigated) showed that all three plantings were able to survive a 24-hour exposure to 15° F on December 3.

Project B-85

Irrigation for Maryland Tobacco

During the 6-year period 1957-1963, an average return of \$150 per acre was obtained from irrigation. Gains in 3 years more than offset lack of gains

in the other three. Tobacco grown with adequate moisture cured with lighter colors and brought a higher price on the market.

Project BOQR-84

Ammonium as a Fertilizer

University scientists continued the study of the influence of crop residue on potassium and ammonium availability in soils. Their results indicate that some organic materials expand clays in such a manner that a portion of the fixed potassium and ammonium becomes available for plant use.

Other studies of the effect of ammonium on the uptake of potassium by plants revealed that ammonium at low concentrations (10^{-8} N) had little influence on K uptake. If ammonium

concentrations are increased slightly, potassium uptake may be increased; however, further ammonium increases result in a detrimental effect of ammonium on potassium uptake.

This detrimental effect of ammonium on potassium accumulation by plants was found to be more than competitive inhibition (competition between potassium and ammonium on the external surfaces of the roots for entrance into the root).

Project O-57

Relationship of Soil and Weather to Consumptive Use of Soil Moisture by Field Crops

Alfalfa was able to extract 7½ inches of water and bluegrass 6 inches of water from the Chester silt loam soil in 1963. Thus, the wet soil was able to supply the average water requirement of these crops for about 6 weeks without rain. The Manor soil had a similar moisture supply, while the Beltsville silt loam supplied only 4 inches of water and the crops showed severe drought symptoms. Previous research on the Monmouth loamy sand at the Tobacco Station showed that corn, tobacco,

alfalfa, fescue, Bermudagrass and bluegrass used the same amount of water each day and were able to extract water to the same depth (about 30"). Alfalfa was able to extract water from a deeper depth in the Chester and Manor soils and thus extracted about 1½ inches more than the bluegrass. Moisture was measured with the neutron meter and moisture use is being compared with daily sunshine, temperature, relative humidity and amount of air movement. *Project O-70 (NE-48)*

Soil Aeration and Crop Growth

Soil aeration is being measured by a new technique developed by The Maryland Experiment Station. Soil gas samples are being taken from 2-foot hypodermic needles inserted in the soil of experimental plots. Small serum bottles are evacuated in the laboratory and are filled with the soil air sample in the field by inserting the upper end of the 2-foot needle through the stopper of the bottle into its evacuated interior. Carbon dioxide, oxygen and nitrogen concentrations of the soil air are obtained in the laboratory by inserting 0.15 ml. (equal in volume to about 3 drops of water) with a special syringe into a gas partitioner which makes all three determinations in 4 minutes.

Soil aeration is important to cultivated crops because the plant roots require oxygen to live and perform their main functions of water and mineral uptake. Carbon dioxide released by the roots and soil microorganisms must also be removed from the soil since it becomes toxic to the roots. Some determinations with this equipment show carbon dioxide contents of the soil air

to be as high as 9% following heavy rains, which would be detrimental to the roots. *Project O-72 (NE-11)*



Measuring soil moisture with a "neutron meter". A small pipe is driven into the soil to be tested. The atomic style meter "reflects" whatever drops of water may be found and registers enough information to enable the soil scientist to report the extent of moisture in the soil.



Constant progress is being made in the use of new devices used for exploring the soil. The operator here is thrusting a hollow probe into the earth to obtain samples of gases in the soil. The tube contains a clearing wire, which forces out the dirt. The probe is then thrust into a bottle, from which the air has been previously removed. The soil, air and other gases are put into the bottle for analysis.

High Nitrogen Fertilization of Pastures

Trends in forage production are in the direction of stored-feed programs. On the other hand, many farm operations do not lend themselves to this type management, and some farmland is best suited for pasture.

Where land is best suited for pasture it is important that the pasture be as productive as possible. High nitrogen fertilization of perennial grasses is a method of increasing dry matter production, and a study underway at the Agronomy-Dairy Forage Research Farm is designed to compare dairy cow response under three levels of nitrogen fertilization of orchardgrass.

This work is of interest to both the

Agronomy Department and to the Dairy Department. The agronomists are interested in dry matter production, weed encroachment and quality management of the pasture; the dairy scientists are interested in the nutritive value of the forage.

This work has shown that dry matter production and carrying capacity of orchardgrass pastures can be doubled over orchardgrass—clover pastures by the use of 200 pounds of nitrogen per acre. No detrimental effects were experienced by the animals when they grazed this high nitrogen pasture.

Project BG-1

Some Corn Hybrids Show Drought Tolerance

For the second consecutive year a severe summer drought limited yields in the corn tests at College Park. Less than 1.5 inches of rain fell during a 43-day period beginning in early July and extending into August. As a result, two 28-entry tests at this location averaged only 46 and 58 bushels per acre, respectively, or about half a crop. Some hybrids

grown in dry tests in both 1962 and 1963 at this location show considerable consistency in response to drought. Open-pedigree hybrids showing above average performance in these dry tests were: Pa602A, Ohio W64, and V.P.I. 426. NE912 was near average and Conn. 870 was well below average.

Project B-50

Critical Look at Pastures for Beef Cattle is Needed

During several years numerous pasture species have been evaluated for beef cattle. The results of these studies have demonstrated that Midland Bermudagrass, a relatively newcomer to the forage picture in Maryland, is one of the most productive species, especially when this pasture is sod-seeded with cereal rye. Since Midland can best be grown without a legume, at rather high nitrogen rates, it becomes increasingly important to evaluate this species for beef production utilizing different rates of nitrogen. Highly fertilized Midland grazed at an immature stage of growth is high in nitrogen content,

yet needs to be evaluated by grazing animals for its nutritive value. Since energy for the animal's metabolism may be the limiting factor on such pastures, the study of supplemental-grain feeding should also be studied.

Experimental Midland pastures totaling 22 acres have been uniformly treated during the past year and will be evaluated during the 1964 - 65 growing season. Treatment variables will be pasture fertilization and supplemental-grain feeding of the animals. Yearling Angus steers will be used in the test.

Project B-56-j

Double Exposure to Drought Limits Wheat Yields

A very dry seedbed during October delayed emergence and limited fall growth in field tests near College Park. A second drought period hit the crop at a critical stage of growth during May when heads were forming. As a result yields were 10-15 bushels below normal for the test field. The early

varieties suffered most. The stiff-strawed varieties, Redcoat and Monon, were among the low yielders. Even with this serious limitation by drought all varieties responded to spring topdressing with 33 lbs. of nitrogen per acre.

Project B-66

Varietal Improvement in Barley and Oats

The barley variety, Besbar, continued to perform well. In the uniform nursery several experimental selections showed considerable superiority over the recommended varieties, Wong and Kenbar.

Norline, a relatively new winter oat

variety, continued its good performance.

Brave, a new spring oat variety from Illinois, outyielded old varieties in the College Park drill-plot test.

Project B-67

Pasture Improvement With Sod-Seeding

Permanent pastures frequently decrease in productiveness because of a lack of adequate legumes in the sward. It is often difficult or impossible to plow these fields and reestablish a more productive pasture mixture. Techniques have been developed which result in good legume stands in grass-dominant pastures without complete renovation. This was accomplished by modifying the furrow openers of existing commercial sod-seeders to facilitate small-seeded legume establishment.

The production per acre of Midland bermudagrass pastures can be in-

creased by one-third by sod-seeding cereal rye into the dormant Midland sod in the fall of the year. This sod-seeded cereal furnishes late fall and early spring grazing when the Midland pastures are dormant and unproductive. Indications are that nitrogen unused by the Midland during the summer months can be efficiently utilized by the rye during winter months. This technique makes it possible to further increase production per acre by producing a forage on the land during more of the year.

Project B-75

Red Clover Breeding Investigations

The polycross progenies from 24 selected red clover clones were compared with Chesapeake for yield and persistence. During the 2-year duration of this experiment, 8 of the clones had polycross progenies which produced more dry matter than Chesapeake. The

stands of all polycross progenies from the 24 clones were better than Chesapeake after 2 years; however, the best entry had a stand of only 13 percent. Work now in progress is aimed at improving red clover persistence.

Project B-76

Clay and Secondary Mineral Genesis in Maryland Soils

A comparison of the data accumulated under this project with that available from other states indicates that the clay or minerals of Maryland soils are more closely related to those of soils of southeastern United States than to those of soils in the glaciated regions of northeastern and northcentral United States.

This relationship may be explained largely by the greater age of soils outside of the glaciated region. It may also be related to the warmer present-day climate of this region. Whereas the clay minerals of soils of the glaciated regions have largely been inherited

from the soil parent material, a much higher proportion of the clay minerals of soils of Maryland and the southeastern United States have been produced by weathering. The minerals produced by weathering, such as kaolinite, are much more inert (in terms of providing plant nutrients during further weathering) than most of the inherited clay minerals, such as potassium bearing illite. A conclusion from these relationships is that fertilizers are more needed for efficient crop production in Maryland than in the regions that have been glaciated.

Project O-54

Specific Gravity Soil Test Studies

Ground magnesium limestones are being investigated in reference to the uniformity of composition of the different size particles. Studies to date indicate that particles from the same stone of the same size may vary in chemical composition and reactivity in the soil.

particles based on the difference in their specific gravity is being developed. It is hoped that this new method when used in conjunction with X-ray identification methods will increase both the specificity and the accuracy of the present system of clay identification.

Project O-55

Fertilizers as Related to Method of Application

The response of corn to boron fertilizers was investigated. The average corn yield results from experiments located

in 6 Eastern Shore counties are given in the following table:

Corn Fertilizer Experiment

Testing Boron and Boron + Lime
Corn Yield at 15.5% Moisture*

No Boron*	Boron 1.1 lbs./acre	Boron 1.1 lbs./acre* + 1 Ton of limestone
bu./acre	bu./acre	bu./acre
108.5	106.5	110.2

*Boron and limestone were plowed down.

Boron fertilizers did not increase corn yields. However, in the fields studied, barren stalks were not present in excessive numbers. If boron is deficient, boron fertilizers will reduce barren or blank stalks and in this manner increase yields.

Eastern Shore showed that one soil gave an increase in yield with the application of zinc fertilizers. A field experiment on this same soil showed no increase in corn yields even though characteristic zinc deficiency symptoms were evident in the untreated immature corn.

Project O-62

Applying Nitrogen on Legume-Grass Mixtures

Nitrogen should not be applied to ladino clover-orchardgrass or red clover-orchardgrass mixtures if the legume comprises more than 25% of the sward. Work at the Forage Research Farm showed that when 50 or 100 pounds of nitrogen per acre was applied to forage mixtures containing more than 25% legume, some clover percentages were substantially reduced. Forage yields were increased but usual-

ly not enough to pay for the nitrogen applied.

The best policy is to rely on the legume to fix nitrogen from the atmosphere and supply itself and the associated grass with the needed nitrogen. However, when the percentage of the legume becomes too small (less than 25%) to provide sufficient nitrogen for the grass, the mixture should be treated as a pure grass stand. *Project O-65*

Germination, Development, and Competitiveness of Crabgrass Under Varying Conditions

Work was done on the susceptibility of various species of crabgrass to two rates of Atrazine applied both as a pre-emergence spray and postemergence spray when the crabgrass was 1-to-1½ inches tall. It was apparent that sublethal dosages of Atrazine lowered the percent germination of large crabgrass but did not affect the growth of the plant once it germinated. The small crabgrass germinated well, but its vigor and height were reduced considerably.

Observations in field plots indicated that lack of control of crabgrass by Atrazine and other herbicides in dry seasons was due to the herbicide remaining in the upper ¼ inch of soil, but the crabgrass seeds in this layer did not germinate. Instead, those seeds which were in the moisture zone (2 inches) did germinate and were able to grow up through the herbicide layer and avoid injury.

Project B-95

Nutrient Balance in Orchardgrass

The need for balanced fertilization of grass becomes more evident when large amounts of forage are removed from the field. Dry weather prevented high plant removal in an orchardgrass study near the Forage Research Farm. Consequently, definite nutrient balance relationships of phosphorus, potassium, and magnesium were not established.

The following trends were observed: (1) a 4-to-1 ratio of applied potas-

sium to phosphorus appeared to be optimum for maximum yields; (2) magnesium contents in harvested forage of 0.262% to 0.319% occurred when the highest yields were obtained, and (3) high rates of potassium reduced magnesium uptake sooner than they reduced calcium uptake. Future study should shed more light on these apparent relationships.

Project O-71

Use of Herbicides to Control Weeds in Forages

The cruciferous weeds (wild turnips, yellow rocket, shepherds-purse, and peppergrass) have shown varying reactions to 4-(2, 4-DB). Results from recent tests indicate that wild turnip is easiest to control and peppergrass is intermediate. Yellow rocket is most difficult and requires a higher rate than wild turnip. Shepherds-purse presents a special problem since it evidently

germinates mostly in the spring. Hence fall treatments do not control this weed. Control of Canada thistle at 1½ lbs/A of 4-(2, 4-DB) has been consistently good.

Weed control trials in spring seedings of alfalfa this year indicate that R-1607, trifluralin, and EPTC will be safe.

Project B-79

Physiological and Ecological Studies of Effects of Herbicides on Plants

In an attempt to gain some information about the phytotoxicity, injury symptoms, and persistence of linuron (3-(3, 4 dichlorophenyl)-1-Methoxy-1-methylurea) pots were seeded to soybeans and treated with 1,2,4 and 6 lbs/A of linuron. A watering schedule was imposed to result in low moisture conditions (20 ml per day), medium (40 ml every other day), and high moisture (40 ml per day). When the soybeans were 8-12" they were cut off. The 4 and 6 lbs killed the beans after they were 1 to 2 inches tall. Injury symptoms on the beans were described as mottled grey around the edges and

then working back to the petiole. Intervential tissue dropped out, leaving holes in the leaves. Injury showed first on the oldest leaves. This chemical did not prevent germination, but death occurred shortly after emergence.

It has been found that linuron when applied pre-emergence in the greenhouse did not affect beans, but it did injure beans just emerging from the soil; so it appears that the selectivity is by means of the soil cover over the beans. When applied to one bean leaf no linuron was translocated and the leaf abscised.

Project B-80

Effects of Physical Characteristics of Herbicides Used on Corn and Soybeans

Formulations of amiben were tested in the greenhouse and in the field. The standard liquid-spray, several plastic sprays and a number of granular formulations were evaluated in terms of weed control, soybean tolerance, and rate of release of amiben. For weed control, none of the formulations were superior to the liquid and many were less effective. Weed control by granulars was related to size of granule, rate of release of amiben and chemical form of amiben on the granules. Charcoal granules were the most promising from

the standpoint of developing a slow-release formulation. Slow-release formulations show some promise for increasing the length of time weeds are controlled and for reducing the hazard of soybean injury.

Studies were conducted on the efficiency of oil versus water as carriers for herbicides used in controlling nutsedge, a troublesome perennial weed. In the greenhouse, a napthenic oil appeared to be superior to water as a carrier for atrazine, EPTC, and a combination of both herbicides.

In the field five herbicides were applied in nitrogen solutions to test their efficacy as compared to water carriers. It was found that there were no distinct advantages or disadvantages to this type of treatment under the weather conditions prevalent this year. The suspensions formed by some of the wettable powders were not too good, and it was evident that supplementary agitation will be needed. Treatments applied after the corn was 3-to-8 inches tall did not materially affect the yield of the corn.

Soybean Varietal Improvement

A new variety of Group IV maturity was released cooperatively by Maryland, Delaware, U.S.D.A. and other collaborating stations. Delmar is similar in maturity to Bethel and Kent. This variety has resistance to the fungi that cause purple stain and pod and stem blight. It also has some resistance to a

Experiments designed to test the effect of cultivations on weed control by herbicides were not too successful, due to a severe drought. It was apparent, however, that R-1607 or trifluralin plus one cultivation was considerably better than either herbicide alone or one cultivation alone. The biggest contribution of the herbicide was seasonal control of grasses and control of weeds in the row. Cultivations most effectively controlled the broadleaf weeds between the rows.

Project B-94

common species of the root-knot nematode. Seed appearance is good; medium size with a yellow hilum. Yields are equal to Clark or Bethel and the oil-protein ratio compares favorably with other commercial varieties.

Project B-43

Physiological and Biochemical Basis of Herbicidal Selectivity

Selectivity is the most valuable feature of chemicals used as herbicides in crop production. How is it that a chemical can kill weeds yet not injure a crop growing in the same field? For example, the herbicide, amiben (3-amino-2, 5-dichlorobenzoic acid) controls weeds in soybean fields.

Carboxyl labeled amiben-C¹⁴ is being used to study the fate of this herbicide in soybean, a resistant crop and in pigweed, a very susceptible weed. When amiben-C¹⁴ was applied to the soil, the roots of both pigweed and soybean took up large quantities of radioactivity. However, once inside the roots, amiben moved up to the top of the plant much faster in pigweed than in soybean.

Even a resistant plant such as soybean is susceptible to amiben if the rate

of herbicide is high enough. Under such conditions amiben was translocated into the soybean tops as readily as it was into the pigweed tops. Thus, the selectivity of amiben appeared to be related to its mobility in plants.

Further, it has been shown that in the roots and tops of both pigweed and soybean amiben was present in some form of a conjugate. Acidic or alkaline hydrolysis of the conjugate released amiben. In present studies the identity of the conjugate and its possible function in selectivity are being sought.

The use of paper chromatography and a strip scanner which detects the location of the radioactivity on the chromatograms has greatly facilitated these studies. (Fig 1).

Project B-98

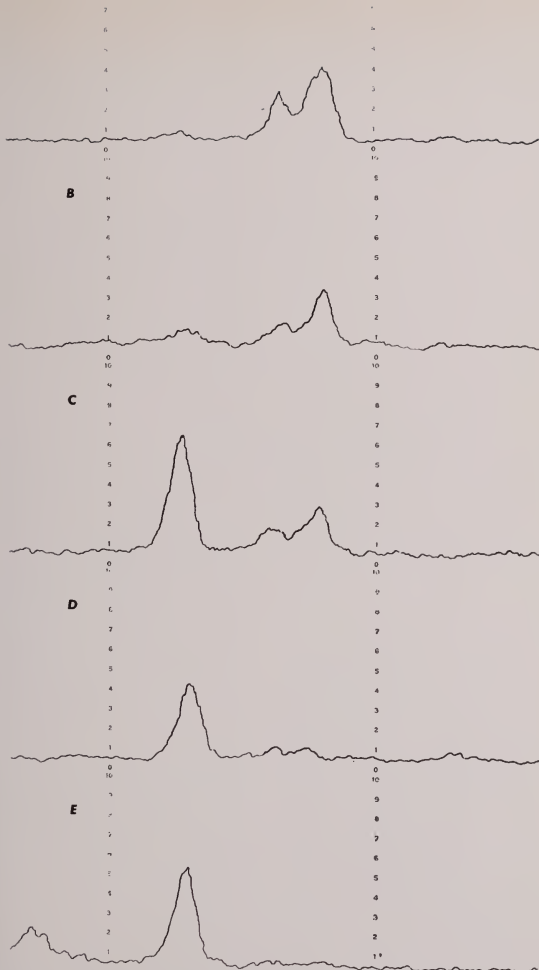


Fig. 1 Plants treated with amiben-C14 were extracted and the extracts were chromatographed on paper. The paper chromatograms were then run through a strip scanner. Scans shown represent extracts of: A. Pigweed; B. Soybean; C. Soybean plus pure umiben-C14; D. Soybean after alkaline hydrolysis; E. Soybean after acidic hydrolysis. The "isotopigraphic" movement is shown in each graphic line.

Rotations for Maryland Tobacco

Cropping cycles with tobacco grown in alternate years have resulted in yields between 1450 and 1650 pounds per acre and acre values near \$900. The use of redtop and alsike clover,

winter rye followed by Sudangrass, or winter barley followed by soybeans, as intervening crops resulted in acre returns of \$930 to \$950 in a 3-year test.

Project B-68

Midland Forage Quality and Yield High Without Stand Loss

Continued high yields of Midland bermudagrass were obtained with nitrogen rates of 200 pounds per acre or more. Yields leveled off between 400 and 600 pounds of nitrogen per acre. Harvesting once every 3 weeks produced between 4 and 5 tons of high-quality feed, while less frequent harvest-

ing produced yields of over 8 tons per acre. These high-producing treatments, however, were low in quality. The results of this and previous years' data, demonstrated that close frequent harvesting of Midland was not injurious to Midland stand.

Project B-74

Forage Crop Variety Evaluation in Maryland

A bromegrass experiment was established at the Agronomy Dairy research farm, Ellicott City. The purpose of this experiment is to compare the open-pollinated progenies of 25 selected bromegrass clones with four check varieties.

Twenty-eight varieties of alfalfa were established at the same location in order to evaluate them for establish-

ment, vigor, forage production, "resistance to insects and diseases, and other agronomic characteristics. Preliminary data indicate that Moapa and AS 13, southwestern varieties, which have stimulated slight interest in Maryland because of their vigor and regrowth after cutting, had the greatest stand losses from 1963 to 1964.

Project B-77

Dicamba and Control of Weeds in Cultivated Crops, Turf, and Brush

How to use chemical herbicides in the normal cropping system, obtain long-lasting broad-spectrum weed control and yet not have herbicides persisting in the soil is answered in part at least by the practice of using two herbicides. Each one is used at a lower rate than one would be used alone. This allows one to mix a broadleafed weed killer with a grass killer to obtain complete control. Several combinations have been tested and some combinations are being marketed.

The weed problem in soybeans is yielding somewhat to the immense pres-

ures being brought to bear by chemical companies and research workers. Among new herbicides are trifluralin, linuron, and a combination of dinitro and NPA. Emphasis is now being placed on difficult weeds such as jimsonweed and morning glory.

Hard to control turf weeds (knotweed, speedwell, sheep sorrel) show signs of being susceptible to a new material, dicamba. This herbicide must be used in combination with 2, 4-D since dicamba will not control buckhorn plantain.

Project B-78

**Fertility and Clipping Management Effects
Productivity and Persistence Grasses**

The use of summer annual grasses has skyrocketed in recent years. The trend toward greater use of these forages has come about because of improved varieties, and because of a series of dry years experienced recently by Maryland farmers. These crops are expensive to establish, and it is important that the most efficient management practices be followed.

This study has shown that yields of approximately 3.5 tons per acre can

be obtained if the plants are harvested as green chop when they are 30 inches high. This is in contrast with half this yield when the plants are pastured at 18 to 24 inches in height. Three harvests per season were obtained from the green-chop clipping management. Nitrogen applications in excess of 100 pounds per acres did not result in significant increases in yield.

Project B-82

Limits of Nitrogen Fertilization of Corn Silage

Corn silage has the potential to produce the highest yields of energy per acre of any of our present forage crops. In order to realize this potential, farmers are inclined to apply high rates of nitrogen fertilizer to the corn.

This study has shown that rates of nitrogen over 150 pounds per acre did not result in substantial increases in yields under the conditions of this experiment. The work was conducted on a moderately eroded Manor loan, and

rainfall was restricted throughout much of the growing season.

The silage harvested from the high nitrogen plots (200 and 400 pounds per acre) contained high amounts of nitrate. This was converted to nitrogen dioxide during the ensiling period, and the poisonous gas was present around the silos during the 24-hour period after silo filling.

Project B-86

Maximum Production in Tobacco

Among the common Maryland varieties, Wilson has maintained an average yield of 2017 pounds per acre for 4 years. It has out-yielded Pennleaf 1, a cigar-filler variety from Pennsylvania, by 100 pounds per acre, also had an acre value of \$1167, which was \$160

more than Pennleaf, and was worth 5 cents more per pound. Catterton fell behind Wilson in yield by 384 pounds, but was worth 7.7 cents a pound more than Wilson, and was only \$95 lower in acre value.

Project B-87

Physiochemical Studies of Tobacco

Irrigation of the 1963 tobacco crop reduced the content of total nitrogen by 6 to 14 per cent, and the content of total alkaloids by 5.5 to 18 per cent. These differences were more extreme in the 1957 crop, when the drought was more severe.

Studies were made on the composition of Wilson and Catterton varieties

grown in a time of harvest study. Wilson contained 18 per cent less total nitrogen, 25 per cent less total alkaloids than did Catterton. Total alkaloids dropped sharply at 72-74 days in the field for both varieties. These dates coincide quite well with the best dates of harvest.

Project B-89

Moisture and Uniformity of Tobacco Seedlings

A consistent moisture supply at the soil surface was essential to uniform emergence of tobacco seedlings in a test conducted at the University of Maryland Tobacco Experimental Farm. Daily light irrigations of the plant bed at the time of germination tripled the number of good transplants pulled over the number obtained from similar irrigations applied every 3 days. The uniformity of emergence was also superior

with the daily irrigation as indicated by 38% of the total transplants being pulled at the first drawing whereas 29% were pulled in the first drawing of the 3-day irrigation treatment.

The results of this research also indicated that where irrigation was not utilized a reduction in fertilizer rate improved the stand and uniformity of emergence of tobacco seedlings.

Project B-96

Modified Cultural Practices and Tobacco Quality

The effect of stage of maturity of the tobacco plant at harvest upon the curing quality indicated that the rate of curing was proportional to the degree of maturity. The curing rate increased with an increase in maturity at time of harvest. Tobacco harvested in an overmature stage suffered a reduction in the desirable red color and

showed more tan and yellow colors. The overmature tobacco stripped out a lower percentage of the best "thin crop" leaf grades and a higher percentage of "seconds" or leaf grade grown near the ground, which was of less value.

Project B-101

Improved Strains of Tobacco

Replicated variety tests were conducted on a heavy and light soil at the Tobacco Experimental Farm. Two black shank-resistant lines along with six breeding lines with resistance to wildfire, black root rot and tobacco mosaic were evaluated. In addition three standard varieties and three farmer selections were tested. Both yield and quality were measured. Chemical determination for percent nitrogen and total alkaloids were made. The black

shank lines looked promising in yield and quality. In general the six breeding lines carrying multiple resistance were inferior in quality when compared with the standard varieties.

Twenty-eight farmer strains were grown in single row plots for comparison with four standard varieties. This test indicated that the farmer strains were generally inferior in yield and quality to the recommended varieties.

Project J-95

Field and Laboratory Soil Characterization Studies

Field studies of the relationship between soils and their environments were made on soil survey field reviews in Anne Arundel, Carroll, Cecil and Worcester Counties in cooperation with SCS personnel. Soil surveys are very

valuable for providing background information for making soil and water management and conservation recommendations, for evaluating land values, for community planning, and for making soil engineering interpretations.

Detailed laboratory chemical and physical determinations were made on samples from 15 different soils. These determinations give quantitative measurements for such things as particle size distribution, cation exchange capa-

cities, percent base saturation, free-iron oxide content and organic matter content. Such information is essential for the classification of soils and for making practical use interpretations.

Project O-48

Fall-Versus Spring-Applied Nitrogen for Orchardgrass

Nitrogen can be applied late in the fall for good orchardgrass production the next spring. Certain conditions are necessary, however. The soil temperature must have fallen below 42° F at the time of nitrogen application and must remain below that temperature until spring. Also, an ammonium source of nitrogen, such as urea or ammonium sulfate, must be used. These conclusions were derived from evaluation of the results of a 3-year study conducted on the Plant Research Farm. The 42° F soil temperature was usually reached by

December 15 and, on one occasion, by November 22. Some of the nitrate portion of ammonium nitrate applied at these dates apparently was leached out the soil over the winter. Although the yield response to fall application of ammonium sources of nitrogen was not significantly lower than that to spring applied nitrogen, the nitrogen content was lower in the fall fertilized forage. The disadvantage would have to be weighed against the advantages of fall fertilization.

Project O-63

Banded Phosphorus Gives Alfalfa a Fast Start

Phosphorus is needed for fast growth of alfalfa seedlings. Treble superphosphate, diammonium phosphate, and ordinary superphosphate were banded or broadcast with banded or broadcast alfalfa seed, respectively. No significant differences in seedling establishment among phosphorus sources were found.

Early growth of alfalfa receiving no applied phosphorus was markedly inferior to that of plants receiving adequate phosphorus. Band seeding resulted in faster initial growth than that of alfalfa which was broadcast seeded. However, when phosphorus supply was inadequate, this advantage was temporary.

Potassium Related to Winter Hardiness of Alfalfa

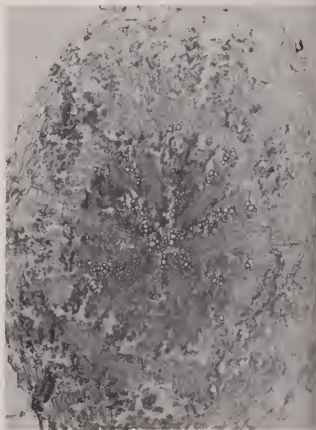
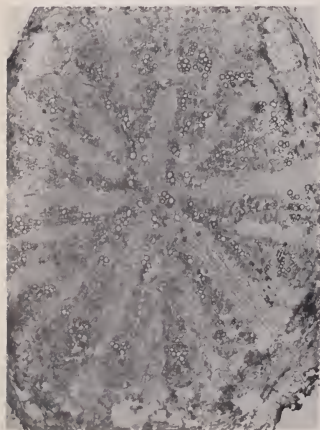
Winter survival of alfalfa is often increased by potassium fertilization. A greenhouse and field investigation is being continued in an attempt to find out why this occurs. Preliminary work indicates that potassium-sufficient alfalfa roots have xylem vessels which are larger in diameter and are more uni-

formly distributed than those found in potassium-deficient roots. Theoretically, root cells would be less susceptible to freezing injury if these conducting tissues (xylem vessels) carry a large volume of electrolytes and are uniformly distributed in the root.

Project O-64



Band seeding makes it possible to place adequate phosphorus near the seedling for a fast start. Alfalfa plots in the foreground received phosphorus in a band near the seed, while the plots directly behind them received no phosphorus.



Potassium may influence winter hardiness of alfalfa by affecting the xylem size and distribution in the root. The potassium-sufficient root on the left has larger, more uniformly distributed xylem vessels than the potassium-deficient root on the right.

ANIMAL SCIENCE

The nature of the animals and the kinds or research projects necessary to help solve many of today's practical problems, be they in the fields of breeding, feeding and nutrition, management or meats, result in projects of reasonably long duration. This year's report deals primarily with the most recent results obtained from new phases of projects mentioned last year. Some of the new phases are a direct result of the expansion of facilities or of the advantageous inclusion of new techniques now available. Producers of commercial beef cattle, sheep, and swine, as well as breeders of purebred stock, will profit from these changes and from the extra care exerted by researchers in their planning and checking of projects and results.

BEEF CATTLE

Progeny-Performance Testing of Beef Cattle

Study initiated to evaluate and improve the University of Maryland cattle herds through progeny-performance testing is being continued. The summary of past records and new data which have been collected will give some indication of the status of the present herd.

Prewaning data for both the Angus and the Hereford herds are summarized for the years 1955 through 1962. The average daily gain from birth to weaning for all Angus heifers was 1.71 pounds, and 1.77 pounds for all steers. The average for the 1964 Angus calves was 1.82 pounds per day from birth to weaning for the heifers, and 1.94 pounds per day for the steers.

The 1964 Angus calves are the first by the present herd sire. He was selected on the basis of size, rate of gain, and conformation. Available carcass data on his half-sibs were also considered in making the selection. The

pre-weaning record of approximately 50 percent of the cows in the present Angus herd are in the heifer rate of gain data given above.

The average daily gain from birth to weaning for the Hereford calves from 1955 through 1962 was 1.55 pounds for the heifers and 1.81 pounds for the steers. Prewaning records on the progeny of the senior herd sire are for 2 years, 1963 and 1964. The average daily gain from birth to weaning was 1.70 pounds for the heifers and 1.72 for the steers. In a feed lot performance of the 1963 Hereford calves on a 168-day feed test, the Hereford heifers gained 2.20 pounds per day and the steers 2.16 pounds. Feed consumed per hundredweight gain for the Hereford steers was 587 pounds of grain and 126 pounds of hay. The heifers consumed 582 pounds of grain and 105 pounds of hay.

Project C-41

Expansion of Facilities for Cooperative Research on Breeding in Beef Cattle

In the past year two additional barns have been built for the individual feeding of beef calves; bringing the total capacity to 88 head. One professional and one subprofessional worker, plus part-time help, have now been assigned to the work. Although the "B", research, and "Wye" herds (at Wye Plantation, Queenstown, Maryland) are separate entities, much of the work, such as taking weights and measurements at various ages, has been extended to the Wye herd animals.

About 140 calves were weighed and measured at 28, 225, and 365 days of age. Forty-two B herd and some Wye herd calves were fed individually. Heifers were fed from weaning to 900

pounds or 393 days of age, whichever came first. Bulls were on test until they reached a weight of 1000 pounds or 393 days of age, but the bulls had to have a minimum age of 365 days before removal from trial. Feed consumption, weights, and gains were kept on a 28-day basis from weaning (225 days) to end of trial. Fifteen of the males weighed over 1100 pounds at 365 days. Special matings of animals within the Wye herd for the formation of the research herd are continuing. The herd has been in existence too short a time to justify detailed analyses of the records.

Project C-39

Study of Inter-relationships of Bodily Parts and Carcass Cuts

See Frontispiece, page VI, for illustration

Exploration of the large number of measurements and weights of wholesale cuts (360, total) in an attempt to reduce the number of variables to a significant, reasonable number, so that practical applications of the results may be made, is under way. Unique programs have had to be written in connection with the use of the University of Maryland's computer. These programs will be usable for other studies. With the cooperation of the Department of Experimental Statistics, University of Georgia, a number of exploratory factor analyses have been made.

Factor groupings and loadings have indicated some specific associations of measurements. When weights of various wholesale cuts were included in the

system, communalities of over 0.8 were obtained, in some instances involving the rib, even though the range in live weight of the animals was only 50 pounds (900-950 lbs.). Use of a principal-components analyses was made, about 0.7 for difficult rough round in reference to the rib and values of about 0.7 for difficult rough round cuts. Cross sectional areas of the cuts were of importance in predicting the weights. Some exploratory work has been completed on finding measurements (of the live animals), which may be useful in predicting the areas, and also in estimating the weights of the cuts.

Project C-41

Ruminal Acid Production and Animal Performance

The volatile fatty acids (VFA) of the rumen constitute the primary products of the ruminal fermentation of carbohydrates. The VFA are the major sources of absorbed energy of the ruminant, and it has been estimated that they provide 70 percent of the total absorbed energy. The proportions or molar ratios of the several acids (chiefly acetic, propionic, and butyric acids) which constitute the VFA vary with diets. Low-energy, high-fiber diets are associated with high proportions of acetate and low percentages of propionate and butyrate. High-energy, low-fiber diets which contain higher proportions of starch are associated with high percentages of ruminal propionic acid and relatively low percentages of ruminal acetate. Inasmuch as the high-energy diets are those normally associated with rapid gains in beef cattle and lambs, it follows that the molar percentage of the ruminal VFA might be associated with rates of gain. Studies have been conducted to test the supposition that some portions of the differences between rates of gain of animals fed the same diets might be attributable to variations between individuals in the proportions of ruminal VFA.

Ewes were group-fed hays or silages, and the ruminal VFA correlated with the changes in body weight. Molar percents butyrate, molar percents propionate plus butyrate, and the sum of the molar quantities of butyrate plus propionate were positively correlated with weight gains. The molar percent acetate, the acetate : propionate ratios and the acetate equal : propionate plus butyrate ratios were negatively correlated with the weight changes of the ewes.

Group-fed steers were allowed free-choice consumption of alfalfa hay and of corn supplemented with soybean oil meal. Ruminal VFA were not correlated significantly with gains during the 4-week periods preceeding the sampling of ruminal contents either within individual sampling periods or overall periods. There was no control over the hay: concentrate ratios consumed by individual steers; thus it is reasonable to expect that some individuals which achieved high energy intakes and rapid gains also consumed a ration with relatively wide roughage : concentrate ratios and a resulting high proportion of ruminal acetate. Similar results were obtained with feeder lambs allowed *ad libitum* consumption of corn and alfalfa.

Among sheep individually fed on high or low levels of alfalfa prepared as pellets, meal, or long hay there were significant correlations between weight changes and ruminal VFA. Molar percent acetate was negatively related to weight gains and molar percents propionate, butyrate, and propionate plus butyrate were positively correlated with gains.

Results to date indicate that no meaningful relationships between ruminal VFA and animal performance can be established unless the dietary variables which contribute to variations in the VFA, such as roughage : concentrate ratios, are controlled.

In vitro studies have been conducted to test the hypothesis that glucose concentration, which should in the intact rumen be a function of rate of polysaccharide degradation, influences the molar ratios of VFA produced. Increases in glucose concentrations in incubates of ruminal fluids prepared from

both concentrate- and roughage-fed animals resulted in increases in molar percent propionate. Factors which influence the rates of ruminal cellulose fermentation are being studied with the objective of describing situations favorable to rapid cellulose digestion. If

more rapid digestion of roughage diets could be achieved, it is reasonable to expect that the net energy values of the digestible nutrients from such diets could be increased to be more comparable to those observed with high-concentrate diets.

Project C-42

Effects of Forage Moisture Studied

It is now well established that high-moisture, hay-crop silages (70% or more moisture) are frequently inferior to well preserved low-moisture silages in terms of feeding value as measured by dry matter intake and animal performance. These effects appear to be related to the water content of the forages, as stored; but the low palatability of the wet silages cannot be explained by differences in apparent digestibilities or by water content, *per se*. The evidence now available indicates that differences in fermentation, and thus the resulting end products of fermentation during the ensiling process, are responsible for the variations in silage values which can be associated with forage moisture. Studies of the effects of forage-moisture content upon dry matter intake and ruminal acid production in sheep have been conducted.

Direct-cut (30% dry matter) and wilted (50% dry matter) alfalfa silages, artificially dried alfalfa hay (92% dry matter), direct-cut (30% dry matter) early and late harvested Sudan grass silages, and Sudan grass hays 90% dry matter) were compared in the first experiment. Sheep fed alfalfa hay consumed more dry matter and gained weight more rapidly than did any other groups in the trial. Sudan grass hays were less palatable than alfalfa but did support body weight gain, and the early harvested hay was superior to the late harvested. Sheep fed the wilted

alfalfa silage were the only silage-fed animals to gain or maintain body weight. The greatest weight losses were encountered in the animals fed the late-harvested Sudan grass silage. Daily dry matter intakes ranged from 4.5 lb. per head for alfalfa hay to 1.1 lb. per head for the late-cut Sudan grass silage and were reflected in the weight changes of the animals.

There were significant differences in the molar percentages of the various ruminal volatile fatty acids (VFA) between alfalfa hay and alfalfa-silage-fed sheep, but total VFA concentrations were not affected by the forages. Alfalfa silages resulted in higher proportions of acetic acid and lower percentages of propionic and butyric acids than did alfalfa hays. The wilted silage resulted in a narrower acetate : propionate ration than did the direct-cut silage. No significant differences in molar percents acetic or propionic acid due to forage preparation were observed in sheep fed Sudan grass forages. The Sudan grass hays resulted in molar proportions of butyrate which were significantly higher than those observed in the silage-fed animals. Molar percentages of propionic acid were slightly higher in sheep fed Sudan grass forages than in the alfalfa-fed animals. Molar percent butyric acid was significantly correlated with dry matter intake and weight gains, but no such relationship was observed between

molar percent propionate and animal performance.

In a second study, silages were made from alfalfa and from seed-stage and boot-stage Sudax (a Sudan grass—Sorghum hybrid—DeKalb). The silages were ensiled as direct-cut or wilted. Alfalfa of the same cutting was also stored as hay. Results of a feeding trial with lambs showed that:

(1) Alfalfa hay was superior to wet or wilted silages in terms of dry matter intake and body weight gain. (2) Wilted silages of alfalfa or Sudax were more acceptable than the corresponding silages with less dry matter and (3) Seed-stage wilted Sudax silage was inferior to the corresponding silage at the boot stage. Analyses of ruminal contents for VFA revealed that molar percents acetate or butyrate in hay-fed animals were not significantly different from those fed alfalfa silages, but the proportions of propionate were significantly higher. Ruminal fluids of lambs fed wilted alfalfa or Sudax silages contained lower percentages of acetate and higher percentages of propionate than did those of animals fed direct-cut silages. It was noted that the ruminal contents of animals fed alfalfa hay or silages contained significantly lower proportions of acetate and higher proportions of propionate than did those fed Sudax forages. Sudax silages made at the seed stage resulted in higher

proportions of ruminal acetate and lower percents of propionate and butyrate than did silages from forage of the same species at the boot stage. Thus in this experiment, the forages which were most palatable consistently resulted in narrower acetate : propionate and acetate : propionate plus butyrate ratios, a situation which would be expected if relatively high molar percentages of propionate and butyrate are accepted as indications of a good nutritional state in the animal.

Alfalfa hays ground through 3/16 in., 3/8 in. or 1 1/2 in. screens and also in the long form were fed to lambs as the air-dry hays or with added water to bring the moisture content to 65%. Unlike the wet silages, these forage preparations, (with the exception of the coarsley ground hay) were more palatable when fed with added water. Weight gains varied directly with the dry matter intakes of the sheep. Neither dry matter of the forages as fed nor degree of fineness of grinding significantly affected the molar proportions of the ruminal VFA, but the acetate : propionate ratios were consistently lower in the groups which showed the higher rates of gain. These results with unfermented wet hays support earlier observations that moisture content, by itself, does not account for the lowered palatability of high-moisture silages.

Project C-25-a

Nitrogen Source and Rumen Function

Experiments have been conducted to gain more information about the use of nonprotein nitrogen (NPN) in ruminant diets. In recent years the importance of the quantities and ratios of the volatile fatty acids (VFA) produced in the rumen to the economy of the ruminant animal has been demonstrated by many research workers. Diets which

have high net energy values per unit of digestible nutrients result in relatively low acetate : propionate ratios in the rumen. High-energy diets also promote the most effective use of NPN, and it may be postulated that protein synthesis is most efficacious when rumen propionate production is relatively high and that VFA analyses of ruminal con-

tents may be correlated with the utilization of NPN. The effects of urea as a supplement to low-quality roughages and the influence of urea on ruminal VFA production, in comparison to that observed with natural protein or proteins *in vivo* and *in vitro*, have been studied.

Lambs were fed ground, pelleted diets of corn cobs, corn meal and molasses supplemented with urea incorporated into the pellet or fed separately in a water-molasses liquid supplement or with soybean oil meal. The soybean oil meal supplemented diet was more palatable than those supplemented with urea and resulted in the highest rates of gain. No appreciable differences in the molar percentages of VFA were noted between the treatments.

Urea supplementation of a diet composed of 75% barley straw and 25% barley grain increased body weight gain and dry matter consumption. The acetate : propionate ratios in the ruminal contents were significantly narrower in the supplemented lambs.

Rumen contents drawn from a group of lambs fed a diet of 15 percent crude protein and supplemented with soybean oil meal and contents drawn from another group fed a 5-percent crude protein diet were used *in vitro* studies. Preparations containing uniformly labeled radioactive glucose were incubated without an added nitrogen source and with soybean protein, urea, or lactalbumin hydrolysate added at various levels. None of the VFA fractions produced *in vitro* was significantly influenced either by sources or levels of nitrogen. Dietary protein did influence production of VFA *in vitro*, and incubates prepared by lambs fed the 15-percent protein diets produced higher

proportions of propionate and butyrate with correspondingly lower percentages of acetate. No consistent results relative to the incorporation of radioactivity from glucose were obtained, but the percentage of activity in the butyric acid fractions consistently decreased with increasing levels of added nitrogen.

A diet composed of corn meal, corn cobs and molasses was fed as a low-protein control or was supplemented with urea or soybean oil meal to make up two medium (12.5%) and two high (20%) protein diets. These diets were fed to sheep which were rotated through all the diets in a feeding trial comprised of five 28-day experimental periods. Feed consumptions were in descending order: (1) medium protein urea (2) high protein soybean oil meal (3) medium protein soybean oil meal (4) high protein urea (6) low protein control. Rates of gain by diet were in the order: (1) high protein soybean oil meal (2) medium protein urea (3) medium protein soybean oil meal (4) high protein urea (5) low protein control. The quantity of urea required to raise the diet to 20 percent protein obviously depressed palatability below that observed with the 12.5-percent protein urea diet. Molar percentages of acetic acid were not significantly affected by either source or level of dietary nitrogen. The urea-containing diets resulted in higher proportions of propionic acid and lower proportions of butyrate than did the soybean oil meal diets. Molar percent butyrate increased with level of soybean oil meal but, in general, the source of nitrogen had more effect upon ruminal propionic and butyric acids than did the percent nitrogen in the diets. Results of these studies indicate that urea supplementation of low-protein diets will increase feed intake and ruminal pro-

pionic acid percentages and that natural proteins are the source of an appreciable amount of the butyric acid

observed in the ruminal contents of animals fed diets supplemented with soybean oil meal. *Project C-36*

Bloat Studies

Bloat in ruminants occurs as the result of failure to eliminate from the rumen gases produced by the microbial population of the rumen during the fermentation of ingested feedstuffs. The eructation of ruminal gases is mainly controlled by the autonomic nervous system. Studies with sheep and cattle have shown that drugs which affect the autonomic nervous system will cause bloat. Atropine (acetylcholine blocking agent) and epinephrine or L-tyrosine or tryanime (sympathomimetic agents) produced bloat and also increased the severity of bloat when administered to sheep bloated slightly from green alfalfa or from a "bloat" diet.

Drugs which oppose the action of atropine and epinephrine depressed the bloating ability of these materials and were also effective in preventing natural bloat from green legumes or feed lot bloat diets. These observations suggest that some components of diets which cause bloat inhibit eructation and have activity similar to that of atropine and epinephrine.

Studies to determine and identify the active factor(s) in green legumes which dispose to bloat are being conducted. During the past year, alcohol extracts, saline extracts, or alcohol and water extracts of green alfalfa failed to produce bloat in fasted sheep or in sheep

previously grazed on grass or ladino clover.

Sheep were grazed on ladino clover after a 12-15 hour fast. In some cases, priscoline (Tolazoline hydrochloride U.S.P., CIBA) was injected into one-half of the animals before grazing, in other cases the priscoline administrations were made after grazing. Slight to moderate bloat was observed in only about one-third of the control animals and prior injections of priscoline appeared to have some effect in lessening the severity but not the incidence of bloat. Priscoline administered subsequent to grazing to ewes which were slightly to moderately bloated relieved the tympany 15-20 minutes after injection. Methanol extracts were prepared from green ladino clover. The feeding of these extracts in quantities equal to 10-12 pounds of original forage was not effective in producing bloat. Alkaline saline extracts of ladino clover fed at the same rates as the methanol extracts produced severe symptoms of toxicity (loss of coordination, paralysis), but only one of four animals bloated and in that case only after several hours. Drenching with 5-gram doses of tyrosine or tryptophane or mixtures of the two was ineffective in increasing bloat in sheep grazing ladino clover.

Project GC-45

SWINE

Diets and Feeder Design for Suckling Pigs

Dry feed for baby pigs which is supplemental to sows' milk during the suckling period has two major functions

for the improvement of overall efficiency in swine production: The supplemental nutrients support growth in ad-

dition to that which may result from those supplied by the sows' milk. In addition, the transition to a completely dry-feed diet at the same time of weaning is accomplished with less retardation in growth. The study of factors which may influence supplemental feed consumption during the suckling period is essential to achieve maximum efficiency during that phase of development.

During the year, two diets for suckling pigs were tested. The basic differences in these nutritionally adequate diets was one of the sources of protein. The control diet contained meat and bone scraps, replaced by menhaden fish meal in the second diet. The objective of the test was to determine if these feed ingredients influenced palatability and consumption. The diets were made available to the pigs at 7 days of age and were continually available until the pigs were weaned at 35 days. Considerable variation in feed con-

sumption was noted between litters on a per pig basis irrespective of litter size; however, feed consumption and growth during the 4-week period was not influenced by the diet formulation.

Two baby pig feeders were also tested. The feeding trough extended beyond a perpendicular front on one design. In the other design, the feeding trough is placed beneath a sloping front. Pigs began eating from the feeder with the perpendicular front and extended trough earlier, and consumed more total feed during the 4-week period. This greater feed consumption resulted in heavier weaning weights at 5 weeks of age. Observations on the behavior of pigs suggested that the main advantage of the better feeder was the fact that the extended trough provided more opportunity for investigative behavior and chance contact with the feed prior to intentional feed consumption of the very young pig.

Project C-38

Vitamin B₁₂ Requirements in a Minimal Disease Swine Herd

The objectives of this program related to disease control in swine (minimal disease program) were reported in detail last year.

Observations on several gilts which were removed from their dams immediately after birth and reared in isolation suggested that the usual supplemented dietary level of vitamin B₁₂ in the diet (10 milligrams per ton) was inadequate for satisfactory reproduction. Following these observations, gilts were fed diets containing either 10 milligrams per ton or 20 milligrams per ton. The formulation of the diet provided adequate amounts of other nutrient requirements for growth and reproduction.

All gilts reached puberty between 162

and 190 days of age with no difference in age at puberty associated with level of supplemental vitamin B₁₂ in the diet. The intensity of estrus, length of the estrous cycle, and conception rate were not influenced by the dietary level of B₁₂. Those gilts which were permitted to farrow produced normal litters of 8 to 12 pigs. Previously observed symptoms of vitamin B₁₂ deficiency did not recur.

These results, in addition to other observations, indicate that the nutritional requirements for reproduction of swine isolated from their dams immediately after birth do not differ appreciably from those indicated for swine reared in a normal maternal environment.

Project C-34

Protein Requirements for Swine at Different Feeding Levels

Limited, or restricted, feeding of swine from 100-125 pounds to a market weight of 200-210 pounds has been of increasing interest to many swine producers in recent years. The objective of this feeding method is a further improvement of carcass excellence that must be primarily achieved through selective breeding. A number of experiments at several experiment stations have shown a reduction in the proportion of fat in the carcasses of market hogs following restrictive feedings. In some instances, there has also been a significant saving through improvement of feed efficiency. Development of automated feeding equipment for this type of feeding management has made possible the practical consideration of this kind of feeding management. Prior to this development, the cost of labor for restricted feeding was much in excess of the anticipated increase in returns.

Two experiments, utilizing 120 pigs, have been conducted to evaluate selected protein intakes at two levels of feed restriction during the finishing phase of market-hog production, from 100 pounds to 200 pounds. The higher

level of protein studied was 0.85 pound per pig per day which approximates the level of intake for pigs fed a 13% protein diet, on full feed. The lower level was 0.72 pound per pig per day, approximately equal to the expected intake of pigs full-fed on an 11% protein diet. Each protein level was fed under conditions of feed restriction resulting in 85% and 75% of full-feed intake and was compared to a full-fed 13% protein control diet.

Backfat thickness was significantly reduced on carcasses of pigs fed at both levels of feed restriction, regardless of daily protein intake. Pigs on the lower protein intake were somewhat, but not significantly, fatter at both levels of feed restriction. Indicators of leanness, such as loin eye area and yield of the four lean wholesale pork cuts, were greater for the carcasses of pigs fed the restricted diets. The lower daily protein intake resulted in small reductions in the indicators of leanness. The efficiency of converting feed to gain in live weight was essentially the same for all feeding treatments.

Project C-35

BOTANY

The Botany Department provides for studies on the fundamental nature of plants—their classification, structure, genetics, physiology, and biochemistry. Research activities of the department include many topics of interest to practical agriculture, and its scientific publications add to the store of basic information that is improving our understanding of the living organisms. Investigations center on higher plant species as well as the micro-organisms which may aid in their growth or threaten their survival.

Improved Strains of Maryland Tobacco Resistant to Disease

Maryland tobacco is comparatively resistant.

Present research on development of resistance in Maryland tobacco to root disease fungi shows there is considerable natural resistance to black root rot (*Thielaviopsis basicola*) and fusarium wilt (*Fusarium oxysporum* f. *nicotianae*). The F_3 of Morgan 59 now has a high degree of resistance to black shank (*Phytophthora parasitica* var. *nicotianae*), fair resistance to black root

rot, and high resistance to fusarium wilt. TF_2 of Catterton \times Morgan 59 shows a low resistance to black shank, but good resistance to black root rot and fusarium wilt. The F_1 of the (Catterton \times Morgan 59) back-crossed on Morgan 59 shows a higher resistance to black shank than the previous F_2 cross, with no change in black root rot or fusarium wilt.

Project J-95

Identification, Characterization and Control of Certain Viruses Affecting Economic Plants

A four-year test to determine weight and quality losses (due to tobacco mosaic (TMV) virus) in Maryland tobacco shows that the greatest loss in weight and quality (dollars) occurs when tobacco is inoculated at planting time. Fifty percent of this loss may occur when plants are inoculated at topping time. Thus, there is as much loss in the time between topping and harvesting (9 days) as between planting and harvesting (78 days). The loss due to TMV after topping was not known until the above tests were run. Growers lose thousands of dollars each

year from TMV because they use no precautions against inoculating the tobacco with the virus at topping time.

Losses drop considerably if tobacco has not been inoculated with TMV until after 6 weeks' growth. If TMV is inoculated, after 6 weeks only about two-thirds of the leaves show mottling due to TMV; after 8 weeks only about half the leaves at the tops of plant show mottling. It is interesting that there is a greater gain in weight and dollars in tip-grade leaves that have TMV than in tip leaves without mosaic.

Project J-98

Control Treatment of Soil and Underground Parts of Plants

Cytological study of plants parasitized by a species of *Helicobasidium* indicate all tissues are invaded in tobacco, tomato, fern, and pine seedlings. Potato starch cells are completely filled with the mycelium, as are cells of certain algae. Cells of some mosses are filled with hyphae until the pressure exerted bursts the cell walls. In pine seedlings stems the epidermis is invaded, and the phloem and cortical cells are replaced

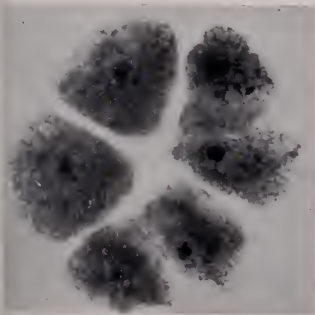
by the hyphae of the fungus. Xylem and zylem rays are invaded and the pith is replaced by the fungus. Penetration of the plants infected is by pegs, through injured tissue, and through stomata of higher plants.

Work is also continuing on control of nematodes of tobacco, strawberries, and certain vegetable crops. New materials are compared to older established nematocides.

Project J-93

Genetic Deficiencies in Corn

The hereditary factors of corn are carried in 10 pairs of chromosomes. Each pair is distinct in structure, and all 10 can be identified in the pollen mother cells by use of the microscope. X-ray treatment of the pollen causes breakage and losses of genetic material in chromosomes of the sperm cells. Deficiencies of known hereditary factors can be identified in the first generation following X-irradiation of the pollen.



Irregular distribution of the chromosomes, due to deficiency of chromosome 1 in corn, has resulted in the formation of six spores instead of the normal four. These spores will not develop into functional pollen.

Large seedling populations were screened for genetic deficiencies induced in chromosome 1, the longest of the chromosomes of corn. In addition to numerous plants with losses of small segments in chromosome 1, three plants were obtained which did not have a chromosome 1 from the male parent. X-irradiation of the pollen thus had resulted in the loss of an entire chromosome 1, and these three plants each had 19 instead of 20 chromosomes.

The 20 chromosomes of corn normally associate as 10 pairs during meiosis and exchange parts prior to the formation of the sex cells. Regular association of the chromosomes is required for fertility. The three plants having a single chromosome 1 exhibited irregular association and distribution of other chromosomes. Since the loss of this particular chromosome upsets association and distribution of other chromosomes, it seems likely that the genetic factors carried in chromosome 1 are concerned in governing the orderly course of events during the development of the sex cells.

Project Hatch, F-18

Milfoil Has Little Fertilizer Value Show Studies on *Myriophyllum Spicatum* L (Milfoil)

Over the past 5 years *Myriophyllum spicatum* water milfoil has invaded the estuarine tributaries of the Chesapeake Bay to such an extent that it posed a serious threat to many industrial and recreational facilities in the area. Commercial oystermen, clammers and those servicing the boating public were particularly concerned. One proposal was that *M. spicatum* might be of value as a substitute or supplement for commercial fertilizers. Hence, its removal would act not only as a control measure but also contribute to the state's economy. A subsequent search of the literature failed to reveal any mineral analysis of the plant as it existed in estuarine water. Therefore this study was initiated to determine the mineral composition of the plant, particularly mac-

ronutrients, when grown under a variety of salinities.

Material was collected at one freshwater site and four areas of varying salinity along the Wicomico and Potomac Rivers over a 9-month period. During the summer months such collections were made every 2 weeks and subsequently once a month. Even under optimal growth conditions analysis for nitrogen, phosphorus and potassium showed equivalent. Additionally, the fresh weight is between 85 and 95% water; thus processing 1 ton of freshwater milfoil would yield, in total nutrients, less than a 100-pound bag of 5-10-5 contains. On a competitive basis, this would seem to preclude its use as a dry fertilizer.

Project F-19

Fungicidal Materials for Field Control of Vegetable Diseases

Studies of the mechanism of action of phytoactin indicate that it prevents fungal growth by inhibiting ribonucleic acid synthesis. Cyclohexamide, on the

other hand, is toxic to fungi because it inhibits the final reaction in the conversion of amino acids to proteins.

Timing Important in Control of Cucumber Scab

Scab (*Cladosporium cucumerinum* Ell. and Arth.) develops very rapidly in cool weather, and the standard fungicidal spray program used by the growers to control downy mildew and anthracnose fails to control scab. Generally, these fungicidal sprays were not applied to cucurbits until the vines began to run and in many cases scab was already present. Recent research has shown that certain fungicidal sprays will control scab, if they are applied to young cucumber plants before scab infection occurs and continued at frequent intervals throughout the season. The first two-true-leaf stage appears to be a good time to start the fungicidal

treatments. The "protective role" and early application of the fungicide cannot be overemphasized. Furthermore, there is some evidence that initial heavy applications of certain fungicides applied early in the growing season may be beneficial and necessary in controlling cucumber scab under severe conditions.

Studies of the mechanism of action of toxicants will aid in the development of more effective fungicides. Field tests provide a basis for recommending the most effective fungicide program for disease control.

Project J-91

Ecological Study of the Patuxent Estuary

As our population expands and suburbs engulf our farm and woodlands, greater and greater demands will be placed on our water resources. Pollution in all its forms—sewage, industrial silt and thermal—will occur. How will these affect the plants and animals growing in and beside these waters? A unique opportunity to study these questions exists in the Patuxent drainage system.

Here is a river which is relatively unpolluted, yet drains an area currently undergoing major changes. Within the year a large steam-driven electric generating plant will be in operation, using water from the Patuxent to cool its condensers, and dumping hot water back into the river. Two separate treatment plants are proposed for its banks. Residential and commercial installations are expected in numbers. The opportunity is here to study not only an immediate change in the area of Chalk Point, near Benedict, but also to establish certain

ecological base lines with which to measure long-term changes.

Obviously all of the plant life in and adjacent to the Patuxent cannot be inventoried. Hence initially the area in the vicinity of Chalk Point was selected for intensive study. Even in a short stretch of the river one must sample the vegetation. During the summer of 1963 permanent transects were established at 30 points along a 12-mile stretch centered at Chalk Point. The vegetation along these lines, which ran from above high water out into the river as far as vegetation existed, was enumerated. Six additional sites were chosen where transects were run from shore to shore. Usually three points were established along each, and every 2 hours for a 24-hour period each point was visited and seven water-quality measurements made. Thus a baseline was established against which future changes can be measured.

Project F-20

Physiology and Culturing of Plant Nematodes

Studies are continuing concerning the biochemical alterations due to galling in alfalfa caused by the stem and bulb nematode, *Ditylenchus dipsaci*. Polygalacturonase was present internally and was discharged into solution by nematodes. This enzyme hydrolyzed pectin to galacturonic acid, with several intermediate compounds being formed. It seemed to aid nematodes penetrate cells locally rather than act in extensive maceration of alfalfa tissues. Initial studies indicate that 7-day-old galled vs. healthy pea tissues contain similar quantities of individual free amino acids. These studies are elucidating biochemical relation-

ships of nematodes to parasitized plant tissues.

Many amino acids in relatively large quantities were discharged into solution by *Ditylenchus trifomis*, *Ditylenchus myceliphagus*, *Paratylenchus penetrans*, *Meloidogyne incognita* larvae and *D. dipsaci*. About 19 amino acids were identified. *M. incognita* larvae and *D. trifomis*, incubated in radioactive acetate and glucose solutions, synthesized and discharged several radioactive amino acids. These studies are providing information on nematode physiology.

Project J-97 (NE-34)

Boron Not Required by Three Species of Fungi

Continuing exploration of the plant kingdom, with respect to requirements for boron (B), *Saccharomyces cerevisiae*, *Neurospora crassa*, and *Aspergillus niger* failed to show B requirements. Growth of the first-named organism (a yeast) was unaffected by 0 to 300 ppm B, but 500 ppm was inhibitory. *Neurospora* was unaffected by 0 to 100 ppm B, but 250 ppm B, and higher, significantly reduced growth.

Mycelial growth of *Aspergillus niger* was unaffected by 0 to 1,000 ppm B, but sporogenesis was completely in-

hibited at 1,000 ppm B; 1625 ppm B completely inhibited mycelial growth. In this latter organism, there were effects of B on reproduction, even though (up to 1,000 ppm B) there was no effect on vegetative (mycelial) growth. This highlights the significance of B in reproduction of a fungus even though, as has often been observed for certain higher plants, there may be simultaneously no effect on vegetative growth in the same range of B concentrations.

Project K-8-c

DEPARTMENT OF DAIRY SCIENCE

Research in the Department of Dairy Science is principally directed toward problems of the physiology and nutrition of dairy cattle and the chemical and physical properties of milk. A balance is maintained between seeking new knowledge and the application of all available knowledge to specific situations or problems associated with milk production and processing. The statements which follow present briefly the results of work conducted during the past year.

Origin of Some Milk Fat Components in the Rumen

Continuation of the work on rumen microbial lipids has revealed that *trans*-11-octadecenoic acid (vaccenic acid) is the major monounsaturated fatty acid present in the rumen. Current thinking is that this acid arises as a result of hydrogenation of dietary unsaturated fatty acids by the rumen microflora. The relatively high concentration of vaccenic acid in ruminant lipids can now be explained on the basis of a rumen origin.

Analysis of rumen digesta lipids revealed that 5 percent of the free fatty acids are keto and hydroxystearic acids. The major keto acid was identified as 16-ketostearic acid (75%); 8 other

ketostearic acids were present. At present, the significance of the oxygenated acids in the rumen is unknown. However, there is indirect evidence that they may play an important role in the metabolism of the rumen microflora.

Ketostearic acids have also been isolated from milk fat. In this instance, 16-ketostearic acid was absent. The presence of keto acids in milk fat may be of importance in understanding the flavor of milk. Under the proper metabolic conditions, the keto acids may give rise to lactones. These lactones are important flavor compounds in heated-milk products and butter.

Project G-48

Citric Acid and Oxidized Flavor in Milk

Citric acid is a normal constituent in milk; and the amount present has been observed to be related to the season. This seasonal change is probably related to change in ration of the cow. Certain changes in ration are known to affect markedly the incidence of oxidized flavor in milk. Studies with model systems showed that small concentrations of citric acid effectively inhibited oxidized flavor. This suggested that citric acid might be involved in the seasonal or change-in-ration effect on oxidized flavor. Modification of the

normal citric acid content in whole milk, ranging from about 90% removal to 100% increase, did not appear to influence the susceptibility of the milk to oxidized flavor. If citric acid does exert a controlling effect on oxidized flavor in milk, the amount required is quite small and not influenced by normal seasonal changes. Rather than to concentration, the effect of citric acid may be due to its association or distribution in the milk system.

Project G-34

Development of a Pesticide Residue Laboratory

The analysis of milk and dairy feed for pesticide residues may become a necessity in the routine operation of quality-control programs associated with milk procurement and distribution. Considerable simplification and standardization of this complex determination is needed to place these analyses within the scope of the typical quality-control laboratory. Procedures in use by well equipped and scientifically staffed government laboratories are beyond the scope of most dairy laboratories.

Because of the pressing need for information on how to cope with a milk-residue problem in Maryland, a laboratory was established at the University, with the object of analyzing a large number of samples in a relatively short time. Analytical and operational procedures developed in this program are within the scope of many dairy quality-control operations. Basically, the analysis was subdivided into several standardized and independent steps

easily carried out. Modification of procedures for preparing samples for analysis resulted in considerable saving of time, material, and labor. Such modifications were not at the expense of sound analytical principles; in fact recovery and reproductibility were improved as a result of elimination of certain steps.

Qualitative and quantitative determinations of chlorinated hydrocarbon insecticides were carried out by electron-capture gas chromatography. Instruments suitable for this are commercially available and easily operated. Though the individual steps are outwardly simple, the overall analysis is complex and must be under the supervision of a competent analyst. Such a facility can be operated at a moderate cost and it may become a future necessity in the control of residue problems and to prevent undesirable punitive action by regulatory agencies.

Project G-35

Movement of Pesticides from Soil to Milk

In response to an area-wide problem concerning the presence of very minute residues of chlorinated hydrocarbon insecticides in milk, an extensive program was developed to provide information and guidance for Maryland dairymen. In addition to providing analytical service and feeding recommendations to individual dairymen, considerable effort has gone into studies concerning the movement and distribution of pesticides, primarily heptachlor, in soil, plants, and dairy cows.

Thirty-eight weeks after initiation of the program, over 2500 samples have been analyzed for pesticide residue. Alfalfa, and to a lesser extent clover, were found to be the only significant

sources or residue in milk. This is the result of the fall application of either heptachlor or dieldrin to the soil for weevil control. This treatment resulted in the absorption of considerable amounts of the pesticide into the root system, including the internal structure, providing a reservoir from which all harvests of the plant were contaminated.

Second growths contained even greater residues than first growths. Feeding studies, including balance trials with lactating cows, indicate that over 80% of the residue present in the ration is absorbed by the animal. Part of the absorbed pesticide appears almost directly in the milk, and the remainder

is retained in the body tissue. The quantity stored in the animal body is related to the magnitude of the residue in the ration and to the length of time over which the ration is fed. Removal of the residue-containing ration results in a prompt reduction in the residue level of the milk, but the pesticide stored in body tissue continues to appear in

the milk for a very prolonged period. Milk fat appears to be the only significant pathway for removal of residue from the animal's body. Methods that may inhibit absorption of pesticide from the feed and also accelerate removal of pesticide from body tissue are being investigated.

Project G-39

Low-Temperature Freezing Improves Ice Cream Textures

A low-temperature freezing process for ice cream, which delivers the semi-frozen product from the freezer at approximately 16 to 17° F., was introduced recently to the ice cream industry.

A preliminary study has been made on the effect of this type of freezing on the properties of the finished product.

Microscopic examination of the internal structure of the low-temperature product reveals that the ice-crystal size may be reduced as much as 40 percent, as from 45-55 microns to 18-22 microns; air-cell size seems to remain about the same or become a little larger, but the air cell wall thickness is reduced considerably.

Before storage, low-temperature frozen products were given a perfect score

of 30 points on body and texture, compared to 29 to 29.5 for the same product frozen in the regular continuous freezer. Results indicate that the low-temperature frozen ice cream, with superior body and texture properties, retained these properties longer under heat shock and storage conditions. After 4-to-6-weeks storage and heat shock periods, or 6 months' normal storage, the body and texture score for the low-temperature frozen product was two to three points higher than for the regular frozen product.

The flavor score of the low-temperature products ranked higher than that of the regular frozen products, due perhaps, to the characteristics imparted by the smooth body and texture.

Project G-42

Dairy Cottage Cheese Whey in Cream Cheese and Orange Drink

The effective utilization of the milk solids of cottage cheese whey is of major importance because of: (1) its nutritional value; and (2) problems in its disposal as a waste product from the cottage cheese operation. A project was initiated to replace some of the kimmilk solids with low-heat nonfat dried whey solids in the production of cream cheese. The cream was standardized to 33% and 16% nonfat solids

in order to eliminate the drainage step in the cream cheese manufacturing procedure. Lactic culture, rennet, stabilizer, emulsifier, and heat treatment were used in the process to develop product acidity and plasticity. The resultant products possessed excellent flavor characteristics. The body properties, ranging from a high-viscosity liquid to a characteristic cream cheese plasticity, were controlled by the level of whey

solids, and stabilizer emulsifier added. A series of products from cream cheese to various party dips will be developed.

Because of the acidity-coagulation properties of casein, it has not been possible to develop a citrus-flavored dairy drink using fluid-milk products. Whey solids seemed to be an excellent source of milk solids in the development of such a product. Orange drink was made with the dried whey solids to levels ranging from 5 to 12% water,

sugar, orange flavor, and citric acid. The controlling factor relative to the level of dried whey solids used was the development of a salty flavor in the product. This saltiness was effectively masked with the citric acid at whey solids levels up to 12%. Incorporation of whey solids in the orange drink made a more acceptable product than the sweetened, acidified flavored-water drink used as the reference control.

Project G-53

Effects of Growth Hormone on the Metabolism of Fatty Acids in Cattle

These studies of the endocrine regulation of fatty acid metabolism are continuing. The previous data have shown that growth hormone treatment of dairy cows results in an increased rate of acetate metabolism. We have now shown that growth hormone treatment results in a 50% increase in the blood plasma concentration of nonesterified fatty acids. Recent data from other laboratories suggest that the blood plasma triglycerides are primarily involved in mammary-gland milk fat synthesis. One trial has been run, therefore, to determine the incorporation of the fatty acids mobilized by growth hormone treatment. The plasma lipo-

protein fractions responsible for triglyceride transport have been found, using radioactive palmitic acid to rapidly incorporate the fatty acids mobilized from adipose tissue by growth hormone. Most of these fatty acids are found in triglyceride, with some in the cholesterol ester fraction. This study suggests that fatty acids entering the blood may be deposited in the cow's adipose tissue, may be mobilized, therefore, and transported to the liver, converted to triglyceride, and then transported to the mammary gland and made available for milk-fat synthesis.

Project G-46

Effect on Bovine Lactogenic Hormone on Blood Glucose and Fatty Acid Concentration and on Milk and Milk Fat Production

This study has just been initiated with a grant of pure bovine lactogenic hormone from the U. S. Public Health Service, National Institutes of Health, to determine the effects, if any, of lactogenic hormone releases at each milking on these measures of metabolism and production. The first trial suggests a

decreased blood glucose and increased fatty acid concentration, no major effect on total milk production, and an increased milk fat percentage. Other trials will be run to the extent that the pure lactogenic hormone is available.

Project G-46

Utilization of Amino Acids for Glucose Synthesis in Dairy Heifers

Previous work in this laboratory has shown a very considerable metabolism of glucose in the dairy cow, both dry and lactating. The sources of this glucose have not been fully determined, with most studies centering on propionate from the rumen metabolism. In 14 trials with fasted dairy heifers, the blood glucose concentration was de-

pressed and the blood nonesterified fatty acid concentration was increased. Oral administration of 10 to 20 grams of amino acids had no effect on these metabolites at 3 or 6 hours post-administration. This study will be continued, using intravenous administration.

Project G-46

Site of Action on Progesterone in the Uterus Being Determined

Studies in laboratory animals, using radioactive progesterone, are demonstrating the point at which progesterone acts on the uterus. These studies are supported by the Experiment Station and receive additional support from the U. S. Department of Agriculture regional project N. E. 41, and the U. S. Public Health Service, National Institute of Health. The inner glandular areas of the uterus appear to accumulate more progesterone than the outer muscular layers. This may be important in placental formation and

in uterine milk secretion in cattle. Progesterone does not go into the nucleus of the cell, which suggests that changes in the basic control of cell metabolism are not involved in the action of progesterone. The largest amount of progesterone becomes associated with lipoprotein in the cell, and this is being examined. Adrenal steroids appear to be located in the mitochondria, where glucose and fat metabolism in the cell are centered.

Project G-50

Determining Steroids Present in Bovine Ovaries and Uteri

Thin-layer chromatographic and gas-liquid chromatographic techniques have been developed for the determination of normal steroids and the metabolites in various tissues. These techniques are being applied to bovine ovarian tissue to confirm reports based

on less sensitive methods. Bovine uterine steroids are being classified for the first time. Preliminary observations show the presence of estrogens, progesterone, adrenal steroids and a number of steroids not yet identified.

Project G-50

In Vitro Techniques for the Study of Progesterone

Two *in vitro* systems for the study of progesterone incorporation in and utilization by uterine tissue have been developed. These are being used to examine uterine metabolism and uptake of radioactive progesterone. The de-

velopment of these techniques will make possible the examination of the processes in cattle and other species, without sacrifice of the animal.

Project G-50

Conversion of Progesterone into Other Steroids

Studies of the metabolism of progesterone being carried out in this laboratory show a very significant conversion of progesterone into many other important steroid hormones. These conversions are being studied in small laboratory animals, using radioactive progesterone prior to similar determina-

tions in cattle. Such conversions of progesterone may explain, in part, the changed metabolism during pregnancy, and may account for a significant utilization of the increased amounts of progesterone present during pregnancy

Project G-50

Nutritive Evaluation of Forages

Intake and digestion trials have been conducted on third-cutting alfalfa hays to estimate the decline in nutritive value with increasing maturity. Harvests, taken 14 days apart at the bud and full-bloom stages, showed a decrease in digestibility of dry matter of 1.8 units. Intakes were slightly higher for the hay cut at the bud stage.

Evaluation of digestion trials completed on first-cutting orchardgrass hays

shows a faster decline in digestible dry matter than found in previous years with alfalfa. Regression equations gave results for decreases in digestible dry matter per day of [0.68% for Potomac orchardgrass and 0.55% for S-37 orchardgrass. S-37, the late-maturing variety, had a higher nutritive value throughout the trials.

Project G-47

Effects of Corn Silage and Energy Levels on Milk Production and Composition, and on Physiology of Cows

Cows milking at the peak of their lactation were placed on rations of either corn silage plus concentrates or corn silage and hay plus concentrates. Each forage treatment was divided into several feeding levels (140, 125, and 110% of Morrison's allowances). In addition, there was a group on restricted corn and a group on restricted hay. Milk production, feed intake, and milk composition (fat, protein, SNF, and fatty acid composition) are being measured. There were no apparent problems with cornsilage groups during the first lactation. However, several calves with goiters were born to cows receiving corn silage as their only sources of forage. The long-term effects on milk production and milk composition cannot be predicted at this time. All treatments will be continued for three lactations

Project BG-3



"Large neck" (goiter) occurred in calves born to cows receiving corn silage as their sole forage.

The Cause of Hypoglycemia in Ruminants

As the ruminant grows from birth to 3 months of age, it develops a relative hypoglycemia which persists through life. The physiological cause of the hypoglycemia is unknown.

Eleven calves have been given 60% to 85% transfusions of adult hypoglycemia blood, according to erythroblastosis procedures. An immediate hypoglycemia developed in each calf.

The minimum glycemia level in the calf was below that of the donor blood and this level persisted for several hours before returning to the pre-transfusion glycemia level. This work proves that the post-natal erythrocytes do not cause the developmental glycemia of the ruminant, but rather, that humoral or metabolic factor(s) are responsible.

Project G-37; G-39

Pancreatic Duct Permanent Cannulation for the Bovine

Ruminant digestion in the bovine's small intestine is not the same as in other animals. This has been confirmed in previous work at Maryland. The ruminant does not have a sucrase enzyme for digesting sucrose (table sugar) and is deficient in many analyses (carbohydrate digesters). A pancreatic duct cannulation procedure has been developed which allows continuous sampling or return of the pancre-

atic juice to the distal end of the duct. Several 24-hour flow determinations have been made on calves. About 1.6 liters of pancreatic juice per 100 pounds of body weight was secreted.

In cooperative work with Kansas State University, the changes in the digestive enzyme content of the pancreatic juice with age will be determined. Flow data and the factors influencing flow will be sought.

Project G-39

Surgical Aforestomach Calves

The ruminant animal has a four-compartment stomach. The first three parts are called forestomach. In the forestomach, forages are digested by anaerobic bacteria and protozoa, which are in turn digested in the fourth compartment. These micro-organisms synthesize a balanced ratio of amino acids and all of the B vitamins.

By surgically transecting the esophagus away from the rumen (first compartment) and attaching it to the abomasum (fourth compartment) a "pseudo," simple-stomached bovine is obtained.

With such an animal it was possible to determine the endogenous amino acid and B vitamin requirements of the ruminant; a feat not accomplished heretofore.

Fourteen calves to 4½ months of age, are surviving this operation at the laboratory. This is the most successful attempt to obtain such a preparation. The calves will be used in nutritional and physiological studies including those mentioned above.

First an adequate diet has to be formulated for normal growth. Our first two attempts to do this have not been completely successful. The first confirmed the inherent deficiency of invertase, the sucrose digestive enzyme in the bovine. The second diet is proving to be unpalatable.

Later, comparative endogenous metabolic studies will be carried out. Females in the group will be grown out to study milk secretion, especially milk-fat synthesis.

Project G-39

Parathyroidectomy and Calcium, Phosphorus, Strontium Metabolism in the Calf

Parathormone from the parathyroid gland located in the neck is believed to be responsible for calcium mobilization. Calves were parathyroidectomized and then depleted of calcium, phosphorus and strontium by the artificial-kidney technique in cooperative experiments at

Oak Ridge, Tennessee. Preliminary results indicate that the parathyroidectomy did not influence calcium, phosphorus or strontium mobilization as compared to that in control (normal) calves.

Project G-37; G-39

Esmond Bubble Oxygenator Tested on Sheep

Many cardiac cases may be brought through an attack if the body can be oxygenated adequately while the cardiac muscle has a chance to recover from the initial abrupt trauma. The Esmond bubble oxygenator was developed to serve as an emergency, but simplified, heart-lung machine for this

purpose.

It was successfully tested on sheep in cooperative experiments at the University of Maryland Medical School and has since been successfully used on man.

Project G-37

Permanent Submaxillary Duct Cannulation Technique for Cattle

Bovine salivation is extremely extensive, owing to the grinding of the coarse diet and the continual remastication (rumination). The extent of submaxillary salivary flow is of interest because saliva is thought to be involved in bloating in cattle.

In cooperative experiments at Kansas State University, the extent and char-

acter of the bovine submaxillary saliva secretion is being determined, using permanent duct-return cannulas. A successful surgery procedure has been worked out, using a combined polyethylene and silastic cannula. A satisfactory flow meter is still being sought.

Project GC-45; G-39

Pearl Millet Depresses Butterfat Test

Pearl millet is a summer annual which has several desirable qualities, such as high yield, disease resistance and no danger of prussic acid poisoning. However, as shown during the last few years, it causes a depression in milk fat percentage and can not be recommended for producing dairy cows. In other types of fat repression, the addition of chemicals which will maintain a constant acidity in the forestomachs

of the cows will prevent the fat depression. Work during the past year has shown that such chemicals will not prevent depression associated with the grazing of pearl millet. Preliminary evidence also indicates that the feeding of 10 lbs. of hay in addition to the pearl millet pasture will not prevent the fat depression. Since the depression exhibited by cows grazing pearl millet differs from that shown by cows

fed high concentrate-low roughage rations, work is continuing to find the cause of this fat depression and relate it to the fundamental knowledge of milk secretion.

Project BG-2

Cows grazing pearl millet produced milk with a reduced percentage of fat.



ENTOMOLOGY

The Department of Entomology conducts research aimed at the solution of practical problems confronting Maryland agriculture. At the same time some emphasis is placed on studies of a fundamental nature which contribute indirectly to human welfare.

Research in European Corn Borer Control and in Soil Pests

The European corn borer has long been a serious pest of sweet corn in Maryland, but in the last few years it has increased in numbers and the need for efficient controls has accordingly increased. Most of the sweet corn grown in Maryland is for canning and freezing. Therefore, corn borer larvae not only reduce yields but enter the ear and become a source of contamination in the processed product. Recent research at this Experiment Station has resulted in the discovery of good insecticides which can control corn borer. The question now arises, how can insecticides be efficiently and safely used to accomplish the desired degree of insect control.

Work is in progress at the University of Maryland to determine habits of the European corn borer and to relate its life activities with corn plant growth, so as to know exactly how to time the treatment for corn borers that attack young corn and to prevent these larvae from infesting the ears. This

work has indicated that complete control of larvae in some stages of growth of young plants does not prevent ear infestation, whereas control of larvae in another stage of plant growth does reduce ear damage. If a better knowledge of this complex relationship could be made clear, chemical control would be more efficient.

In some areas of Maryland, pests of corn that inhabit the soil are serious, especially in early season when the soil is cool and moist. Experiments conducted recently indicate that a method termed "band irrigation" may be an effective way of applying an insecticide to the soil in order to control soil-inhabiting insects such as wireworms, seed corn maggot and cutworms. Diazinon or phorate is applied in water in a band alongside the seed at planting time. This may prove to be effective for improving stands of sweet corn in early plantings.

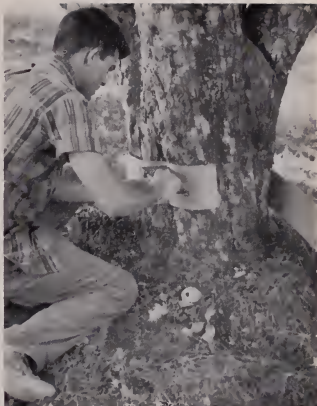
Project H-29-n

New Weapons Against Insects and Mites Affecting Apples and Peaches

This research in 1963 and 1964 consisted of testing recommended pesticides, using three types of concentrated spray equipment in complete spray programs, starting with delayed dormant. One machine was used to apply a 6X, another a 10X, and a third a 33X concentrate.

Approximately 12 acres of apples and 4 acres of peaches were used in these experiments. Each machine was calibrated to apply the same amount of toxicant per tree or per acre, regardless of the concentration used. Records were taken throughout the season to determine the degree of control and the amount of phytotoxicity where the 6, 10, and 33X applications were made. An examination of the records at the end of the season showed no phytotoxicity to fruit or foliage on either apples or peaches. The examination also showed that fruit from sprayed plots of both apples and peaches ranged from 97 to 99 percent clean while unsprayed check plots had only 9.6 percent clean fruit. In this series of tests recommended miticides were used with each piece of equipment and mite control was satisfactory.

In addition, another test, using a dilute application of recommended miticides, was applied against a heavy population of orchard mites. In these tests, the population of mites was allowed to build up to a point where damage would occur before the applications were made. Twelve different materials were tested, using the standard miticide recommendations as comparison. Some of the newer materials showed enough promise to warrant further testing. In all cases where the recommended materials were used, good control of mites was obtained. There were no indications that



Station employee banding apple tree with corrugated paper to collect codling moth larva for emergence studies at the Hancock Field Station.



Corrugated bands in place for codling moth emergence.

resistance had built up in this particular orchard.

Since these experiments were started in 1962, several commercial growers have purchased either the RSM machine used to apply a 10X, or the Econ-O-Mist used for applying a 33X concentrate. Each of these growers re-

port that the control of all pests involved had been satisfactory. The savings in pesticides amounted to approximately 20 percent, and in operational costs up to 40 percent. These reports are most encouraging and could mean an economical lift to commercial fruit growers.

Project H-48

Biology and Control of the Alfalfa Weevil

Two developments during the 1963-64 season increased tremendously the seriousness of the alfalfa weevil problem and were responsible for a broadening of research on this insect. The first was the development of resistance in the weevil to the previously successful insecticides heptachlor and dieldrin. The second was the discovery in milk of heptachlor epoxide and dieldrin as a result of feeding dairy animals treated alfalfa hay. The need for alternate control methods was undertaken with the following results.

1. Good fertilizer and management practices, coupled with early cutting of the first hay crop (somewhat prior to full brood stage) was sometimes successful in controlling alfalfa weevil, especially in first year stands. However, a chemical spray on the stubble after harvest was usually necessary. In first year stands that were not vigorous, due to moisture or fertilizer deficiencies, cutting alone would not control alfalfa weevil, and in second and subsequent year stands, early cutting alone resulted in complete loss of stand. Older stands usually have much severer infestations of alfalfa weevil. Spraying of the stubble with recommended pesticides resulted in good control.

insecticides showed outstanding weevil control, but our experience from past years indicate that most of these will never be usable on alfalfa because of residues on the hay.

3. A broadcast flame cultivation of alfalfa in early spring, when there is 2-4-inches of growth, reduced alfalfa weevil populations by 65%. Although this is not satisfactory, it indicates a possibility of future development. Intensified research activity on this aspect of control is being projected.

4. Work on the chemistry of alfalfa in relation to alfalfa weevil behavior has been inaugurated. Extracts of alfalfa have been prepared and found to contain the principles responsible for attracting the weevil to alfalfa. The results of this work are expected to be applicable to breeding resistant alfalfa and producing baits for use with chemosterilants or insecticides.

5. A study of alfalfa uptake of heptachlor from the soil showed that contamination of alfalfa is not the result of translocation. The only other known mechanism that can account for residues on hay is a mechanical contamination by rain splash, wind blown soil dust and harvesting procedures.

2. A number of new experimental

Project H-71a

Physiology of Insect Reproduction

Very little specific physiological information is available on how the sperm of any animal travel within the reproductive tract of the female. In studying this problem in the mosquito, numerous female *Aedes aegypti* were artificially inseminated. Although the sperm of these insects are capable of very rapid locomotion and their heads are strongly oriented towards certain strong interface surfaces and although they become precisely aligned in a flowing stream, they generally could not be induced to travel within the reproductive tract of artificially inseminated females. It is concluded that sperm activity alone cannot account for their

travel in the female. Her role remains quite unknown.

The female *Aedes* can be force-copulated only once and after this, males cannot be induced to copulate with the female. It is possible that the male recognizes the inseminated female by means of a pheromone (airborne secretion). The source of this recognition is specifically localized on the male's terminalium. The sperm must be within the storage organs of the female for more than 6 hours before they are capable of fertilizing an egg. Studies on the formation of the reproductive organs of the mosquito are in progress.

Project H-72

Studies of Green Peach Aphid on Tobacco

For several years, research on the control of the Green Peach Aphid has been directed toward the development of systemic insecticides for control of this important pest. There are definite advantages in using systemic insecticides, and results of experimentation have shown some of these materials to be of real potential value in controlling aphids on tobacco. Cygon and phosphamidon, as foliar sprays, are two systemic phosphorus-containing insecticides that have proved to be more effective than any of the presently recommended non-systemic insecticides, and their systemic action makes adequate coverage with conventional spray equipment much easier. Systemic insecticides have also

proved effective when applied to the soil as granules; and by applying phorate, American Cyanamid 47470, zino-phos, Niagara 10,242 and Di-Syston to the soil when the plants are young, control of green peach aphid has been effective throughout the season.

At present the green peach aphid is being studied so that its life habits will be better understood. Little is known about factors of the environment that determine the aphid's abundance. Such studies could conceivably lead to development of population or environmental control of its abundance, thereby reducing the economic losses realized each year.

Project H-74

Comparative Morphology and Physiology of Insect Blood Cells

Although the circulatory system of insects is thought to constitute one of their major defense systems, very little critical information is available. The entire heart of the mature cockroach nymph can be severely damaged or destroyed without affecting the activity or life span of these insects. The blood volume is drastically reduced. Heartless cockroaches can even ecdyse into adults. Apparently the heart is capable of being re-formed.

Calcium and extrusion and subsequent dissolution of hemocyte mitochondria are critically necessary for coagulation of the hemolymph (blood) of the American cockroach and four other species of cockroaches. Cell-free plasma will not coagulate unless the hemocytes are present and release substances into it. The cells from one species are capable of causing coagulation of the plasma of other species.

Project H-76

Metabolism of Essential Nutrients and Insecticidal Cells

The proteins in the blood of the American cockroach and a blowfly, *Calliphora erythrocephala* were separated on disc electrophoresis. Of 22 protein fractions resolved from cockroach blood, 11 were found to vary during the molting stage of the insect.

The occurrence of a slow-migrating (in acrylamide gel electrophoresis), high molecular weight protein common to the American cockroach, a blow-fly, the wax moth, the alfalfa weevil, the honeybee, the Japanese beetle and the cabbage looper was observed. The presence of a high lipid content in this fraction suggested a possible functional role of transport. The demonstration of considerable tyrosinase activity in this fraction indicated involvement in the melanization process. This protein frac-

tion had been previously shown to be involved in insects' natural defense to disease, and is found to be depleted considerably during melanization of the blood.

Experiments demonstrated *in vivo* binding of cholesterol to a major blood fraction in the American cockroach. Cholesterol is a precursor to ecdysone, the molting hormone of insects. Attempts to demonstrate ecdysone activity in isolated protein components of cockroach hemolymph was unsuccessful. The binding of pure ecdysone to cockroach serum protein *in vitro* was demonstrated to occur with a number of proteins and showed the possible function of these proteins as hormone-transport mechanisms.

Project H-78

HOME ECONOMICS

Balancing of foods, testing of cooking methods, adaptation of clothing and furnishings to needs and personal selection are a few of the almost unlimited fields of living that keep the Home Economics scientists as busy as housewives at harvest time. Of perennial interest to the homemaker is the basic scientific research that deals with the nutritive elements and flavors of foods, the climatic suitability of dress, good taste and enjoyment of the home, and contribution to the general well-being.

Studies on Cooking Methods with Vegetables

A study has been made of the effect of four cooking methods on the retention of vitamin C and color in two green vegetables, broccoli and snap beans. An adapted Chinese stir-fry method was compared to cooking in a microwave oven and by boiling methods, using large and small amounts of water. Chemical analysis of stir-fried vegetables showed that they retained more of the green pigment than those

cooked by the other methods. Judges scored vegetables cooked by stir-frying higher in color than those cooked by any other method. Cooking vegetables in a small amount of water gave greatest retention of vitamin C but broccoli cooked by stir-frying also retained as much vitamin C as that cooked in a small amount of water. Thus, stir-frying green vegetables is a promising method for color retention.

Nitrogen Equilibrium

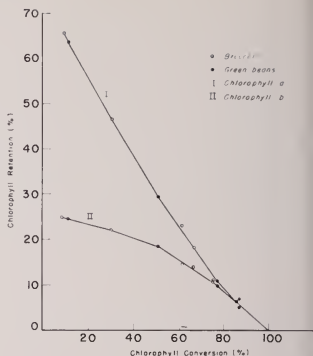
Protein adequacy is determined chemically by analyzing the diet and excretions for nitrogen and determining the balance by subtraction. If the difference is close to zero or greater, the body is said to be in nitrogen equilibrium or in positive balance, respectively, and the protein of the diet is thought to be adequate. Nitrogen equilibrium is possible only when the diet supplies, in addition to the essential amino acids, sufficient nitrogen for the synthesis of the other amino acids required for various metabolic processes in the body.

Minimum requirements of protein

for the individual adult corresponds to the smallest amount of protein that will maintain nitrogen balance when the diet is adequate in other respects. The FAO states that the minimum protein requirements for the adult female is between 0.46 and 0.53 gram of protein per kilogram of body weight (.0736 gm and .08 gm nitrogen respectively). The purpose of this study was to determine the nutritional adequacy of the recommended amount, 0.08 gram nitrogen per kilogram of body weight per day, for college women (example, 28 grams of protein per 56-kilogram woman).

Fertilizer Effects on Pigments in Broccoli

Another study was made to find out whether or not the green and yellow pigments in broccoli could be increased by fertilization of the crop. Three levels of nitrogen and the additions of iron chelate were used. Fertilization was found to have little effect on the pigments. Planting date, however, had more effect. The late-harvested broccoli was higher in yellow pigment (carotene which forms vitamin A in the body) and also in the green pigments (chlorophylls) than that harvested earlier in the fall. This seemed to be due to a less succulent plant growth in the late fall. It was also higher in solids.



Relative stability of chlorophylls a and b in cooked green beans and broccoli.

Nutrition Laboratory Tests Protein Adequacy in Diets

The problem of protein requirements is one of the most difficult in the science of nutrition. At the same time, it is of great importance and of scientific and practical interest to nutritionists, physiologists and physicians and also to governments and international organizations, particularly FAO and WHO.

The primary purpose of a dietary protein is to furnish amino acids in an appropriate pattern for the economical synthesis of protein and other nitrogenous substances essential to the organism and for various other physiological and metabolic roles. Some of the amino acids required for protein synthesis can

be synthesized by the body; others cannot be synthesized in adequate amounts and must therefore be supplied in the diet. These latter are the so-called essential amino acids. Research data indicate that the body needs these amino acids from food in about the same proportions at all times for use in maintenance, repair, and growth. The distribution of the amino acids among our daily meals is therefore another factor to consider in meeting our protein needs. Knowledge of the requirements of man for essential amino acids is still fragmentary and derived from relatively few observations on infants on the one hand, and adult men and women on the other.

Comparison of Diets

Three diets were planned for three successive 10-day periods. The foods of the diets were weighed accurately to the nearest tenth of a gram. The diet was made adequate daily throughout the experiment by the addition of a vitamin capsule and a mixture of minerals weighed out accurately to the second decimal place. Sufficient carbohydrate and fat foods containing no protein were added to the diet to make it adequate in Calories so there would be no loss or gain in body weight of individuals from day to day. Some of these were sauces and cornstarch cookies that were eaten at mealtime; others were candies which were eaten between meals. During the first 10 days the protein was from natural foods with a large portion of protein from beef (pre-experimental diet).

During the second 10-day period the protein was supplied by a basal diet of 3.8 grams of protein supplemented with synthetic amino acids (control diet). The basal diet was bland in flavor and contained little bulk, being made up largely of canned fruit juices and canned fruit. The remainder of the daily diet during this period was made up of essential amino acids in the proportion of the FAO pattern and of non-essential amino acids in the proportion similar to that of milk. The amino acids were weighed accurately to the third decimal place and made into mixes which were then weighed in amounts required by individuals of different kilogram body weights. Since amino acids are sour, have a bitter aftertaste, and are insoluble to a great extent, they were served mixed with the minerals in the fruit juices of the basal diet. It was necessary to use wash bottles to spray the beakers of fruit juice and chemicals to be sure that the sub-

jects got all of the carefully weighed amino acids. The total daily nitrogen was distributed $1/5$ for breakfast, $2/5$ for lunch and $2/5$ for dinner.

During the third 10-day period the protein was supplied by the same basal diet of 3.8 grams of protein, supplemented largely with wheat gluten plus sufficient synthetic amino acids to make the diet equivalent in amino acids and in protein to the former diet (test protein diet). The insoluble wheat gluten was weighed to the second decimal place and was stirred into the fruit juices with the minerals and the amino acids.

The eight subjects participating in the experiment were highly selected for physical health, health habits, preserverence and reliability. They were shown the scant diets, and they promised to eat nothing else but those for the 30 successive days of the experiment.



The determination of urea and ammonia nitrogen.

Food was analyzed for individual amino acids, total nitrogen, fat and Calories. Urine was analyzed for total nitrogen and its nitrogenous constituents of urea, ammonia and creatinine. Feces were analyzed for total nitrogen. Hemoglobin of the blood was determined at intervals throughout the experiment as a check of each student's health.

The subjects were in positive nitrogen balance throughout all test periods, retaining constantly about one gram of

nitrogen. The amounts of nitrogen excreted as creatinine were constant throughout; as those of urea were similar until the test protein period, when they increased slightly; as those of ammonia were similar during the pre-experimental and test protein periods and higher during the control period. The level of 0.08 gr nitrogen per kilogram of body weight was nutritionally adequate when the nitrogen source was natural foods, synthetic amino acids, and wheat gluten.

Prospects of Textile—Furnishing Fabrics for Consumer Satisfaction

Home-furnishing fabrics appropriate for window hangings or slipcovers are selected for study. These fabrics represent favorite sales items in selected retail markets, are of various fiber content and fabric construction, and some have been given special finish for spot and stain resistance or easy care.

Evaluations will be made of performance characteristics—colorfastness to south window exposure and to Fade-Ometer exposure, strength loss, and abrasion resistance. Original fabrics with and without special finish and after drycleaning or laundering will be compared.

Project Y-2 (NEM-32)

Fabrics with built-in qualities for specific uses are available to consumers, who will adjust personal preferences to the performance characteristics sought.



HORTICULTURE

Horticultural research has the twofold aim of bringing the producer his just rewards and the consumer the products of the farm in satisfactory quantity, high quality, and within his means.

The research program thus involves studies ranging from plant breeding to the canning and freezing of fruits and vegetables, carried on in the laboratories and greenhouses at the University, on the experimental farms and on the farms and orchards of cooperating growers throughout the state. Some of the recent results of the research program are briefly presented herein. Scientific and popular articles are released by the Experiment Station.

Tomato Slices—Canned or Frozen?

Quantities of "mature-green" tomatoes are shipped every winter and spring into this area from Florida, California, and Mexico, for use primarily as sliced fresh tomatoes in fresh salads. This is done because the typical canned tomato is not firm enough to be sliced and yet retain its wholeness when used in a salad.

Some of the new varieties developed at this station were much firmer than others. The Pocomoke variety lent itself to slicing prior to canning. Slices of this variety were dipped in a solution of calcium chloride for additional firming. The slices were then filled into cans,

and heat processed. When these slices were removed from the cans they remained as firm and whole as the fresh tomatoes shipped in and were decidedly more attractive in appearance, being much redder and more solidly fleshed.

Use of liquid nitrogen also makes possible ultrarapid freezing of tomato slices. Even by the use of this method, the thawed slices were generally less whole and more limp than the fresh sliced tomatoes or the canned sliced tomatoes. A possible advantage of the frozen slices, however, is that in flavor they are very similar to the fresh.

Project Q-58-m

Nitrogen and Pruning Tests with Peaches

Increasing nitrogen applications up to 3 lbs per tree of ammonium nitrate in the 4th year and 4 lbs per tree in the 5th year resulted in higher yields of Redskin peaches without decrease in size of fruit or any deleterious effect on color when the fruit was harvested at comparable stages of maturity. The high nitrogen applications did delay

ripening so that there was approximately one week difference between the lowest and highest nitrogen treatments. Yields in the 5th year were 152, 163, 179, and 219 lbs per tree from applications of $\frac{3}{8}$, 1, 2, and 4 lbs per tree of ammonium nitrate.

Redskin peach trees that received no pruning except in the first year in the

orchard have produced more fruit than trees receiving a moderate pruning treatment each year. In the 5th year the increase was more than 1 bushel per tree. Size of fruit was slightly smaller on the unpruned trees. Fruit was thinned to a comparable spacing on both pruned and unpruned trees.

Pruned trees have made much greater annual shoot growth than unpruned trees, but at the end of the 5th season the trees were of comparable size. There has also been no discernible difference in leaf color of pruned and non-pruned trees received the same nitrogen treatment. *Project L-73*

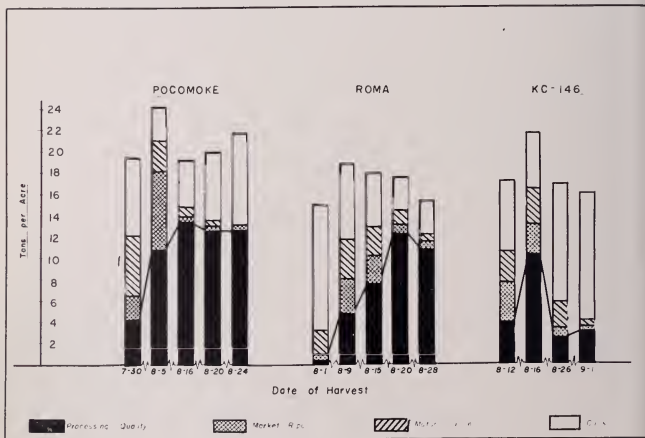
Utilization of Mechanically Harvested Tomatoes

By far the heaviest single cost of producing tomatoes for processing is harvesting, especially where picked fields are harvested by hand every 7-10 days, with perhaps one or two tons per acre each time over. Mechanical tomato harvesters are already in use to a limited extent.

The entire crop of tomatoes could be harvested once only, and only a fraction of the total crop will be suitable for processing, — most of it either too green, or overripe. Three methods by

which a higher percentage of such single-harvest crops may be made usable are:

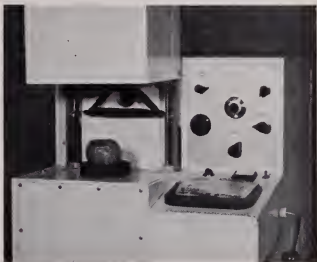
1. Development of new varieties which ripen most of their fruit simultaneously, while maintaining high yields of good quality.
2. Determining for each variety the optimum time for harvest—balancing losses from unripe fruit against losses from overripe fruit.
3. Developing uses for green and overripe fruits.



Of existing varieties, it was found that as much as 90% of the single-harvest crop of the Roma variety can be utilized. Part of the crop would be too green for immediate use, but mature enough to ripen in storage. This variety, however, is suitable primarily for manufacture of paste and ketchup; not for whole tomatoes or juice. The Pocomoke variety recently introduced at this station, is equal to the Roma in its percent utilization, and is suitable for all manufacturing purposes. A mechanism for sorting the tomatoes for ripeness is being developed. It is hoped that it may be mounted on the harvester and thereby sort the tomatoes automatically immediately after they are harvested. Overripe tomatoes would be discarded in the field, the ripe tomatoes taken directly for pro-

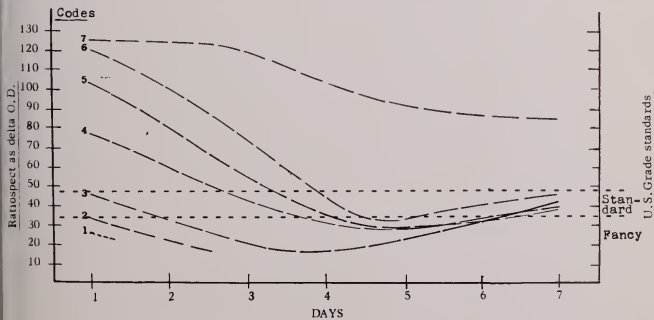
cessing, the mature green for storage prior to processing. Immature tomatoes would be left in the field. The ratiospect (figure 1) designed for sorting tomatoes.

Project Q-58-m



Ratiospect picture. Fig 1. The ratiospect designed for sorting tomatoes.

Ripening Rates as measured by the Ratiospect for Roma tomatoes harvested at different stages of ripeness, and their relation to the U.S. Grade standards.



Reduction of Storage Losses in Sweet Potatoes

Proper conditions of curing and storage of sweet potatoes have resulted in weight losses that closely approach the theoretical losses from respiratory activity. These conditions are a curing period of 5 days at 85° F and 90% relative humidity immediately after harvest, followed by storage at 60° F and 90% relative humidity.

In many commercial storage houses, humidities are much lower than desired. In an effort to obtain a "micro-climate" of high humidity during the curing and storage period, bushel baskets of sweet potatoes were covered on top and sides with 4-mil black polyethylene film, leaving the bottom of the basket open. These baskets were placed at random in the stacks of a commercial storage house in which temperatures were held above

and humidities below recommended levels. Examination at the end of 2 months showed much less weight loss and a much better market condition of the sweet potatoes in the film covered baskets. The improved market condition was largely due to the absence of surface injury. The higher humidity maintained under the plastic has reduced desiccation and darkening of surface areas that inevitably undergo injury during harvesting, even with most careful handling.

Attempts were made to create a larger volume under a favorable high-humidity microclimate within the storage by wrapping stacks of baskets with the film. Results were disastrous, since prevention of air circulation resulted in excessive heating under the plastic.

Project Q-77

Evaluating Flavor

Vapor-gas chromatographic technique opened up new possibilities for the measurement of flavor, since this technique specifically measures the presence of volatile substances, occurring in minute quantities, some of which may be directly responsible for the specific flavors of foods. These volatile substances occur in substantial numbers, and the relation of each such substance must be related to flavor quality individually and in all possible combinations with other volatiles.

Results thus far indicate that 12 distinct volatiles contribute to the flavor of raw and canned green beans, and 18 volatiles to the flavor of raw and canned peas. When these volatiles are correlated quantitatively with flavor re-

sponse of taste panels the results are highly significant ($r = .74$ for beans, and $.77$ for peas). At the same time it is apparent that such gas chromatograms do not provide a complete evaluation of flavor as sensed by the taste panel.

When measures of other attributes of quality such as color, texture, or size, were included in the equations, the correlations with panel evaluation of flavor were practically perfect. This indicates that human response to flavor quality is not solely on the basis of the taste and odor sensors, but also on kinesthetic response. (muscle sense-touch) and appearance (eye appeal) as well.

Project Q-58-r

Statistical Evaluation of Quality

In the absence of objective methods, where human tasters must be resorted to, it is particularly important to analyze the data statistically so that there be assurance that experimental differences in quality are real, and not merely due to chance. A quick rank method was developed at this station, based on the multinomial distribution

and by the use of a computer. If the rank sum is lower than the lower bracketed value, then that sample can be considered significantly preferred. If the rank sum is higher than the higher bracketed value, the sample can be considered as being significantly rejected.

Snap Bean Breeding

Several snap bean breeding lines show promise of being worthy of introduction as new and distinct varieties or as breeding lines for further improvement. One line, Md. 63-84, has been evaluated at 12 different locations throughout the United States. Consensus on Md. 63-84 is that the pods are of exceptionally good quality and are quite similar to the pole Blue Lake in flavor, color and texture. Most processors believe that the pods should be about an

inch longer and that the bush-plant habit should be stockier. Yield is approximately equal to Asgrow Bush Blue Lake.

Md. 63-84 has been released as a breeding line since very few bush Blue Lake types are presently available. Selections for longer pod length and stockier plant habit were made last year.

Project Q-74

Monosaccharides of Apple Cell Walls

Apple cell walls contain a substantial number of monosaccharides relating to textural aspects of the fruit. They are D-galacturonic acid, D-glucuronic acid, D-galactose, D-glucose, L-arabinose, D-xylose and several unknown substances. The chromatogram pictured shows the monosaccharides of the cell wall of the York Imperial Apple. The same pattern of sugars is found in other varieties of apple. These substances in turn are the components of the main polysaccharides of the cell wall which are pectins, hemicelluloses and cellulose. All of these polysaccharides are made up of the above monosaccharides and are broken down during the softening of apples or other fruit. The cellulose, although mainly glucose chains, does contain impurities of the other mono-

saccharides. If one wishes to classify all of the polysaccharides into one group, the term would be "alcohol-insoluble solids." All of the polysaccharides are insoluble in alcohol, as are fats and the proteins of the cell wall. When apples or other fruit ripen, there are changes in the alcohol-insoluble solids which in turn means changes in the polysaccharides, and finally, shifts in the monosaccharides themselves.

Starch is another polysaccharide found in the apple cell but not the cell wall. As the fruit utilizes the last traces of starch, apples are at optimum quality for eating and also for processing. Starch is broken down into glucose units used in the respiration of the fruit.

Project Q-58-p

Fruit Varieties for Maryland Adaptability

The program for development of new fruit varieties with special adaptation to Maryland conditions has proceeded to the point where several types of berries are being propagated for commercial release. Included is a new red steleresistant strawberry and several red raspberry and black raspberry selections to be named next year. A new blackberry was named and released under the name "Raven." It shows promise as a high-quality variety for much of the mid-Atlantic section

and westward through the upper South. It possesses high concentration of ripening, which will aid in harvesting. A second selection for a few days later in season will be released also as propagation is increased.

The development of late-fruited peach varieties has reached the point of second tests; and the release of several is contemplated within a year or two. These will extend the ripening season into October.

Project L-73

Sweet Corn Breeding

Regional testing (Maryland to Maine) of hybrids at five different locations for a 5-year period have provided data for a statistical study of the effects of locations, years, and their interactions on a number of plant and ear characteristics.

From the standpoint of estimating degree of adaptability of varieties, results indicated that the various characters could have been evaluated satisfactorily as follows:

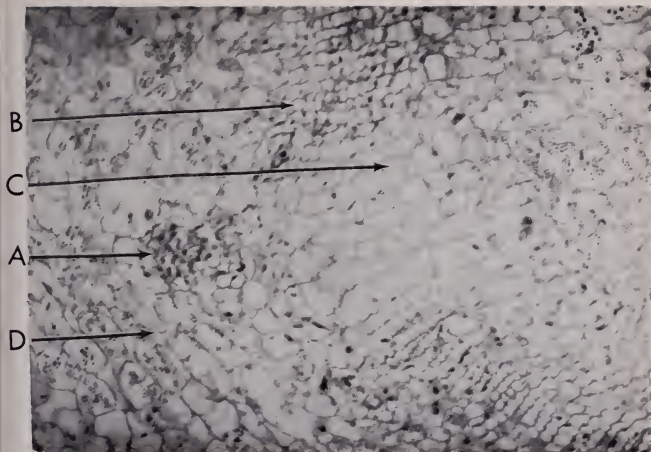
- 1) At all locations for all years—ear height, number of tillers, number of marketable ears, ear weight, husk weight, and ear length.
- 2) At all locations for one year—days to harvest, plant height, kernel width, and pericarp tenderness.
- 3) At one location for all years—husk extension.
- 4) At one location for one year—blank tip, ear width, kernel

rows, appearance of flag leaves, husk tightness, ear appearance, kernel depth, kernel color, and kernel flavor.

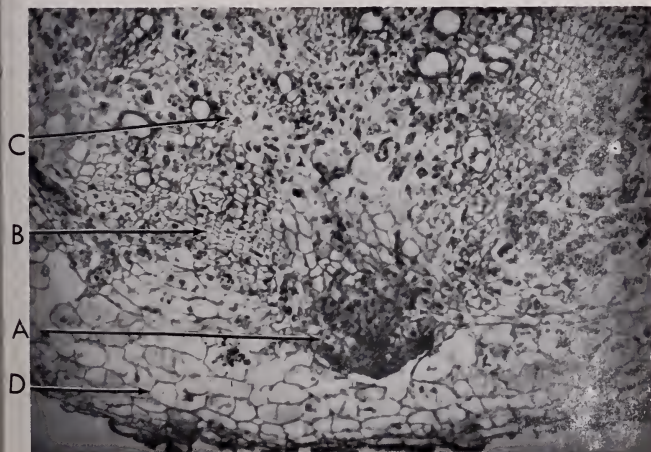
Moving from north to south, days to harvest, plant height, and ear height decreased consistently from location to location. These characters responded primarily to temperature and day-length differences, since seasonal differences were not significant. Tillers per plant, number of marketable ears, ear length, and husk extension responded primarily to seasonal and cultural differences. With the exception of ear length and pericarp tenderness, all other ear characteristics were not significantly different from location to location.

Ear characters recommended for evaluation at a single location for a single year were of a highly heritable nature and were not influenced to any great extent by locational and seasonal environmental variation.

Project Q-81-c



Transections of young Nugget sweet potato roots showing a shoot or root primordium arising from the vascular cambium zone. Details are: A The primordium, B the vascular cambium, C the secondary xylem, and D the secondary phloem.



Origin of Sweet Potato Sprouts

Very young storage roots of the Nugget variety of sweet potato were bedded in sand in the greenhouse. Every day for 2 weeks samples of the roots were removed, killed, and prepared for microscopic examination in order to study the origin and development of sprouts in relation to the overall anatomy of the storage root.

The results show that both sprout and lateral root primordia originate in the vascular cambium zone. The two kinds of primordia often develop together from adjacent regions of the vascular cambium, and in early stages of development it is not possible to determine if the young primordium will develop into a sprout or a root.

During development differentiation

occurs and the primordium begins to take on the typical structure of one or the other. Highly developed sprout and lateral-root primordia show extensive development of radially-oriented tissue extending toward the central axis of the storage root, well beyond the vascular cambium zone. However, examination of less highly developed primordia shows that initiation in the vascular cambium precedes the extension into the region of secondary xylem. Nugget produces very few sprouts, compared to several other popular varieties.

This work is part of a research program designed to find means of increasing the production of sprouts from storage roots of sweet potatoes.

Project Q-77

Quality of Potted Poinsettias in Maryland Greenhouses

Poinsettias for Christmas sales are an important crop of Maryland greenhouses. As the demand for this plant has increased it has been necessary constantly to improve the quality of the plant sold to the consumer, and research has led the way in this improvement. Earlier reports have outlined the procedures necessary for producing healthy, disease-free plants. Production procedures have been established for Maryland conditions, enabling greenhouse operators to time crops more accurately for Christmas flowering and to produce sizes of plants in keeping to market demands.

It has been established that such factors as plant age, soil fertility, and temperature play a role in flower initiation in addition to the controlling influence of daylength. High temperatures and a deficiency of nitrogen or phosphorus have been shown to delay flowering. Delay in flowering due to

high temperature is found in young plants much more than in older plants. To produce a poinsettia in a 6-inch pot, the most popular size in sales, stock plants are topped July 20, cuttings are made on August 25 and the new plants are topped September 25.

It has been shown that cuttings taken earlier than the recommended optimum date can still be used for top-quality blooming plants by the use of growth-retarding chemicals. Two available materials under the trade names of *B-Nine* and *Cycocel* have been found to be suitable for spray or soil drench. *Cycocel* is more effective, and a solution containing $\frac{1}{4}\%$ of the active ingredient can be used either to drench the soil or for one or more spray applications to the leaves. Desirable plants which would otherwise have been too tall can be produced.

Customer satisfaction with the plant depends upon the length of time it re-



The date of topping (or pinching) poinsettias is an important factor in the growing of plants of a desirable height. The plant in the center above was topped at the correct time, September 25.



Excellent poinsettia plants may be produced by taking cuttings and topping plants on scheduled dates, as illustrated by the plant above, propagated August 25 and topped September 25.

Poinsettia plants propagated too early will be too tall, but a growth-retarding chemical can be used to keep plants short. The photograph illustrates the effects of a growth-retarding chemical (cycocel) applied at increasing rates as a soil drench.



Greenhouse culture affects the lasting of poinsettias in the home. All of the plants below were in home conditions for 3 weeks, but at different temperatures in the greenhouse. Left: Plants grown in a cool greenhouse lost leaves sooner. Center: Plants grown in a warm greenhouse retained leaves longer but the flowers were shed earlier. Right: Plants not quite mature lasted longer in the home.



remains satisfactory in the home. Experiments have shown a potential home life of 3 weeks but that this may be affected adversely by cultural conditions while growing the plant in the greenhouse. Temperature, fertility, light intensity, water, growth-retarding chemicals, and maturity of the plant have recently been investigated and found to have an effect on keeping quality. Plants were grown under different cultural regimes in the greenhouse and then placed in a 70° F room to determine the number of days until leaves and bracts fell from the plants. It was found that plants not

yet at full bloom when placed under home conditions lasted longest. Leaves were retained longer on plants low in nitrogen, low in potassium, and grown in a warm temperature at a slightly reduced light intensity. Bracts were retained longer on plants low in phosphorus. The growth-retarding chemical *Cycocel* had no effect on the lasting quality of poinsettias when used at recommended rates, although dosages considerably higher than recommended did have adverse effects on leaf retention.

Project I-74-A

Injured Seed Produce Weak Plants

Snap bean seedlings from damaged seed, wherein 1 cotyledon is missing are less vigorous and less productive than seedlings developing from normal seed with two cotyledons intact and functioning. A further reduction in functional cotyledonary tissue drastically reduces seedling vigor, as shown in illustration.

The effect of missing or nonfunctioning cotyledonary tissue on seedling vigor. Left to right: seedling with one cotyledon missing; two functional cotyledons present; one cotyledon missing and half of remaining cotyledon severed above transverse and nonfunctioning.



Subsoiling Expands Snap Bean Root System

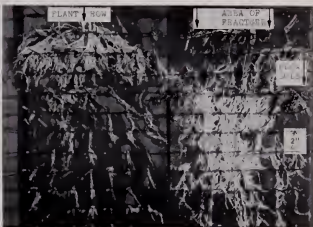
A limited observational test was conducted to explore the possibilities of subsoiling as a means of extending snap bean root growth into the subsoil to take advantage of the moisture reserve often present there. Ordinarily, snap bean roots do not effectively penetrate the relatively impervious plowsole occurring at 8"-10" below the soil surface.

The test consisted of subsoiling alternate raw middles to a depth of 16"-18"

28 days after planting. A root profile was made 56 days after planting with peg boards, pegs spaced 2" x 2", and the results are shown in figure 2. The roots effectively penetrated the subsoil in the area of the fracture and made rapid and extensive growth down to a depth of 3 feet. The root growth shown in figure 1, for a non-subsoiled site, is confined to the soil area above the plow sole.



The root distribution of snap bean plants 56 days after planting, not subsoiled.



The root distribution of snap bean plants 56 days after planting and 58 days after subsoiling raw middles to a depth of 18 inches.

New Machine for Uniform Herbicide Application

Uniform spraying of herbicides around fruit trees has been a problem ever since the development of chemical weed control. A new machine has been built jointly by the Departments of Horticulture and Agricultural Engineering to combine in a sprayer for this task certain other features for experimental work in small lots.

Powered by a conventional air-cooled engine, and equipped with fibreglas tanks, the trailer-mounted sprayer is hooked to a two-nozzle boom fitted to a tractor. The boom is equipped with a quick-acting valve mounted next the tractor driver so that he has instant on-and-off control of the herbicide application.



New machine developed for uniform herbicide application to fruit trees.

A—closeup of the machine.



B—nozzle boom and spray distribution pattern on smooth asphalt.

The boom is also equipped with a pressure gage mounted before the operator. This gage, together with the tractor speedometer, provides for constant surveillance of the two variables involved, and assures control at all times of factors affecting uniform ap-

plication of herbicides. With the tractor speed held constant and spray pressure and nozzle size adjusted to known and desired capacity, this apparatus was found to be convenient and accurate for uniform spraying in orchards.

Project L-74



C—Results in young orchard, Simazine-amino triazole spray with boom applicator.

Boron Reduces Cork Spot of York Imperial Apples—But How?

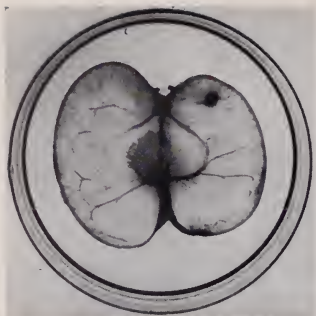
Early season boron sprays were found by the Maryland Experiment Station to reduce effectively the incidence of cork spot, the most serious physiological disorder of the York apple. Although symptoms of this disorder never have been eliminated, the reduction by boron sprays is significant in lightcrop years when considerable cork spot normally develops.

Boron is known to affect the development of vascular tissue in plants, and lack of boron has led to seriously curtailed vascular systems in some species. Tissues of the York fruit and stems were studied under the microscope during two growing seasons. It was found

that vascular systems in boron-treated apples developed the same as in untreated fruits. Further, the vascular system of the fruit appeared to be fully developed before corky tissue appeared in the flesh. Once cork spots developed, vascular strands in the vicinity of the spots deteriorated but the vascular system as a whole remained unaffected.

Thus the role of boron in reducing the incidence of cork spot remains unknown. Work is continuing on this project to study particularly the relationship of boron to calcium in the development of cork.

Project L-79-e



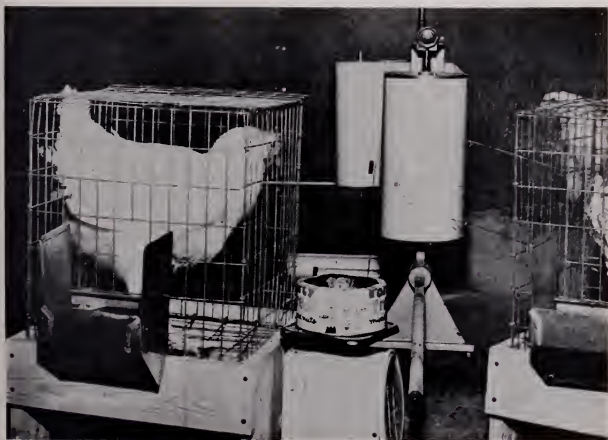
Vascular system in York Imperial apples in relation to cork spot. Right—Cork tissue subtending surface depression. Left—Cork tissue deeply embedded in flesh, with no surface indentation.

POULTRY SCIENCE

As the problems of present day agricultural production become more and more complicated, research dealing with these problems becomes more sophisticated and involved. Delicate interrelationships come to light which complicate the application of new knowledge. As is the case with most any new human endeavor, progress is often rapid in the beginning and as a high degree of refinement is reached, additional progress is correspondingly hard to achieve.

The poultry industry has been a forerunner in promoting not only a practical research but also basic research. As a result, the problems involved in mass production of poultry and eggs have been reduced to quite a demanding science.

The general consuming public is the ultimate beneficiary of this progress in that it has resulted in the production of high class animal proteins at a very nominal cost. Research carried on by the Poultry Department of the University of Maryland is both fundamental and practical. Even the fundamental or basic research, though, is problem oriented. The research laboratories and field stations are always open for inspection, and we are always glad to discuss with interested parties the current research problem.



Every peck of this chicken at the grain in the feed box is recorded on the drum to the right. Data on rations, timing, choice of feed and of form (such as pelleting) goes into the record with the *peck, peck* of the fowl. How much work must be performed to obtain a satisfactory meal and keep her own account?

Protein Adequacy and the Efficiency of Selection for Early Fattening of Turkeys

The original population has been selected into two lines. Each line is being selected for rate of growth during the 2-8 week growing period, with the same amount of selection pressure being applied to both lines. The variable is the fact that one line receives an adequate protein diet during this selection period, while the experimental or test line receives a diet inadequate in pro-

tein. The inadequacy is primarily a deficiency of methionine and lysine. A total of 600 to 800 poults are raised each generation; and from this number 12 males and 48 females are selected for each line.

A companion investigation using *Coturnix* quail is underway in this project.

Project M-400

Effect of Freezing and Reversible Inhibitors on Chicken Sperm

Effort has continued toward finding a satisfactory technique for the freezing of fowl semen. Preservation of semen by freezing would be a most useful tool for chicken breeders and might well enhance the program of artificial insemination currently quite common in commercial turkey production. Unfortunately, techniques which have been so successfully developed for the preservation of the semen of the bull are not at all satisfactory for freezing fowl semen.

Prior to freezing, the semen must be protected by some agent unaffected by the low temperature. Several agents have been tested and although glycerol is somewhat toxic, it is the best that has been used to date. Because of its toxicity, the glycerol must be removed prior to insemination.

Removal was best accomplished by diluting the glycerol and semen mixture with a physiological salt and then

centrifuging to concentrate the cells. The cells readily pack in the bottom of the test tube during the centrifuging process. The excess liquid is poured off and the cells then resuspended in a physiological salt. The slow addition and the slow removal of the glycerol proved to be beneficial. However, neither the rate of cooling below zero degrees centigrade nor the time that the glycerol and semen were allowed to equilibrate seemed to be important factors. These factors have been reported to be important with bull semen.

Small changes in the acidity and the osmotic pressure were not important. Fertility as high as 40% has been obtained with some samples of frozen semen. These are the best results that have been secured, though; and even this low percentage of fertility cannot be regularly reproduced.

Project M-302

Toxicity of the Ohio Buckeye to the Chick

The nut of the Ohio Buckeye (*Aesculus glabra* Willd.) was found to be severely detrimental to chick growth, without specific toxicity symptoms other than apparent dehydration, when

fed at a level of 10% of the diet. No growth lesions were observed on autopsy, with kidneys and liver appearing normal and free of obvious necrosis.

Project M-201

Development of Specifications for Linear Programming of Broiler Rations

Specifications for use in linear programming of experimental broiler rations have been developed and tested in several practical feeding trials. Results of these trials indicate that the present Maryland amino acid specifications, as well as the others, are adequate, provided that suitable amounts of total protein are supplied. Excellent results are obtained when minimum protein specifications are also included. These results show that a computer can be used to determine most economical

concentrations of nutrients, as well as the best combination of nutrient sources, at specified nutrient concentrations. The results of these trials suggest that the nutrients, biotin and thiamine, in starting rations, need to be watched more closely in the future, since these nutrients influence the formulation. These are not normally considered in most other specifications for linear-programmed broiler feeds.

Project M-200

Biological Chick Assay for Available Methionine and Lysine

Studies have been continued in the determination of available methionine content of feed ingredients for available methionine content. In addition, work has been directed to the development of a similar chick bioassay for determining the available lysine content of feed-stuffs. Since these two amino acids are considered to be the first ones to be critically limiting in practical diets composed primarily of corn and soybean meal, it is necessary to obtain good data on the available methionine and lysine content for most efficient

formulation of poultry rations. These bioassays represent an improvement on most other approaches in that they consider differences in intake of feed and relate actual quantities of available lysine and methionine ingested to the performance in the assay. Differences in feed intake can give rise to relatively large apparent differences in assay values for ingredients when actual intake of the amino acid being assayed is not considered.

Project M-202

Nonprotein Nitrogen Changes in Blood Plasma Used in Rapid Test for Evaluating Fish Meals

A rapid test has been devised for evaluating fish meals, which involves fasting the birds for 22 hours, feeding the fish meal on test for 60 minutes and withdrawing blood samples by heart puncture. The protein is then precipitated and the nonprotein nitrogen determined on the protein-free filtrate. With fish meals known to differ in their protein quality as measured by chick

bioassay, differences in the levels of nonprotein nitrogen, as well as their methionine content in the blood plasma, were obtained. The differences in nonprotein nitrogen content of the blood plasma reflect differences in rate of digestion and absorption of the fish meals, thus reflecting differences in their digestibility and quality.

Project M-202

Levels of Fish Meal and Fish Oil

Fish meals have been used at levels up to 15% when the meal was solvent-extracted. However, a total of 1.8% fish oil resulted in a slight fishy flavor, as determined by a test panel. This work indicates clearly that the fish flavor originates from the oil portion and not the solvent-extracted meal portion of the fish product. In other studies where fish oil was added to the

diet in additions to fish meal, a total of approximately 1.6% fish oil (including that supplied by the meal) could be tolerated before any particular effect on taste could be detected. Levels up to 12% of ordinary fish meal had been used with no adverse affect on flavor in the diet of broilers.

Project M-200

Protein Level Studies for Layers

Two additional studies with laying hens fed diets containing different levels of protein, with and without amino acid supplementation, support early work concerning amino acid requirements of layers and indicate that a protein level of 13% is quite adequate, provided that the amino acid requirements are met. In addition, however, data were obtained, suggesting that slight increases in feed efficiency occur in rations for laying hens as the protein level is raised, just as has been found with growing broilers. Although the difference is not great, increasing the protein level from approximately 13% to 18% in rations containing adequate levels of all essential amino acids, appears to improve the feeds efficiency by approximately 3 to 5%. This observation will be studied in greater detail.

Project M-202-c



Maryland layers to be.

Thermolabile Hemagglutinin Factor in Raw Wheat Germ

In studies with growing chicks, raw wheat germ was found to depress growth, cause pancreatic hypertrophy with histological anomalies, and to depress fat utilization. Autoclaving the wheat germ meal for 45 minutes at

121° C, 15 psi corrected these conditions. A hemagglutinin factor was detected in raw wheat germ. Its properties were destroyed by autoclaving for 15 minutes at 121° C, 15 psi.

Project M-200

Stachybotryotoxicosis and Oxalic Acid Toxicity

The water extract from mycelial mat of *Stachybotrys atra* produced necrotic lesions in the mouth of the chick when added to their feed. The lipid extract also produced necrotic lesions when applied on the skin. It had no deleterious dietary effect at the levels fed. Oxalic acid was fed at levels up to 3% of the diet. This level reduced growth

drastically but did not damage the epithelium of the mouth and crop. A level of 1% oxalic acid seems to be the absolute maximum dietary tolerance in standard chick diets containing 1% calcium. It appears that the toxin from *S. atra* and toxicity of oxalic acid are distinctly different.

Project M-201

Histological Effects of Nutrient Deficiencies Studied

The histopathology of bone from chicks fed diets deficient in niacin, biotin or folic acid has been studied. In the epiphyseal cartilage from folic acid-deficient chicks, there appeared to be interruptions of cell formation, maturation and conversion to bone.

Project M-201

This turkey poult, three hours after receiving an injection of folic acid, overcomes paralysis, starts looking for feed.



Effect of Protein Level in Applied Broiler Studies

A series of broiler studies has been conducted in which the protein level of the rations has been increased in two ways: 1) so that all of the essential amino acids are increased, and 2) by the addition and substitution of selected proteins so that the levels of lysine or methionine + cystine (first limiting amino acids) are not increased as the protein level is raised. Increasing the protein level in either fashion has resulted in 5 to 8% reduction in voluntary metabolizable energy consumption per unit gain with little effect on body weight changes. This means that increasing the level of protein without increasing the levels of essential amino acids can improve feed efficiency by as much as 5 to 8% in effect of excess amino acids in the blood manifests itself through an increased

practical broiler rations. This improvement in feed efficiency has been obtained from the addition of a variety of proteins including hydrolyzed feather meal, corn gluten meal, soybean meal, blood meal, gelatin, wheat gluten, and combinations of soybean meal and fish meal. The addition of amino acids to such diets has not given similar results suggesting that the effect is not due to a specific amino acid deficiency.

Under conditions of high ambient temperature (summer), the increase in protein level must be accompanied by an increase in the minimum levels of each critically limiting amino acid if improvements are to be obtained. This observation is consistent with the premise that the appetite-depressing production of body heat.

Project M-200

Affect of Pelleting and Energy Intake on Egg Size

Additional work involved a study of the effect of energy intake and linoleic acid intake on size of eggs from pullets maintained in cages. Various fats including corn oil, soybean oil, safflower oil, tallow and egg fat were added to practical type corn-soy rations at levels from 4.5 to 10%. Significant egg weight responses, averaging 1.6 gm per egg, were obtained with all fats except for a mixture of animal fat and soybean oil in one trial. Egg fat was highly effective in one trial but without effect in another. Generally the greatest increases in egg weights were observed with highly unsaturated oils. The responses also were concomitant with marked increases in caloric intake. When caloric intake was not allowed to exceed that of the control, no increases in egg weight were obtained from the same fat-supplemented diets in three different tests.

In a floor pen trial involving 800 layers, a pelleted feed produced significantly heavier eggs with 7% more metabolized energy consumed than did the same feed fed in mash form. These

diets contained 1.4% linoleic acid by assay, which exceeds the minimum requirement for this essential fatty acid.

These findings indicate that metabolizable energy intake appears to influence egg weight when diets adequate in linoleic acid intake are fed, and that the use of pelleted feeds or feeds containing added fat leads to increased total energy consumption with the production of larger eggs.

Project M-201

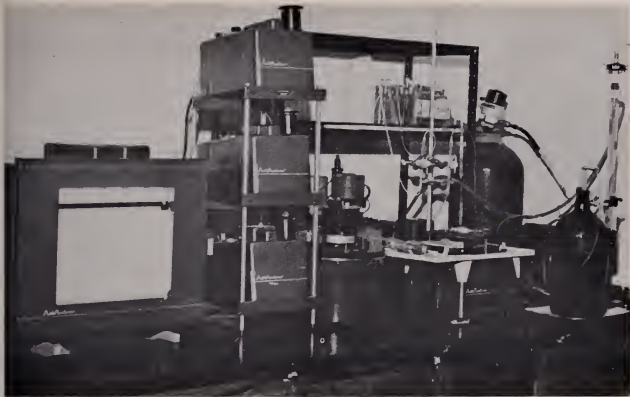


"Hen Fruit"

Amino Acid Balance and Protein Level Affects Food Intake

Experiments designed to study the effect of amino acid balance and level of dietary protein on voluntary food consumption of growing chicks have been continued. It has been shown that the voluntary energy consumption increases in relation to energy needs as the protein level of the ration is reduced. This is accompanied by progressive increases in percent body fat and decreases in percent body protein and water content. In contrast, chicks fed

diets containing the same protein level but varying in amino acid balance show relatively slight differences in body composition even though differences occur in body weight gain. In fact, the most deficient diets resulted in slight decreases in fat content and increases in percent body protein and water. The addition of amino acids other than the one which was first limiting, resulted in still further reductions in voluntary food consumption.



Ammeno acid tester, a new machine for use by poultry producers. It gages the nutritive elements of poultry, feeds, recording the intake, the digestability and metabolism of the birds automatically on the screen to the left.

This difference in voluntary energy intake of the chick can be detected after the first hour following fasting. When imbalanced amino acid diets are offered the chick, feed intake during the first hour is unaffected but subsequent food consumption is markedly reduced at the beginning of the second hour. These diets produce no consistent change in glucose level but do increase the non-protein nitrogen content of the blood.

These observations suggest that the levels of certain excess amino acids or their metabolites accumulate in the

blood when high levels of protein or imbalance protein mixtures are fed. It is believed that these excesses of amino acids influence the voluntary consumption of metabolizable energy by the chick. One possible explanation for the manner in which this action may occur resides in the increased heat production which accompanies the metabolism of amino acids. Subjecting chicks to lower ambient temperatures tends to improve their performance when they are fed diets containing low levels of a single amino acid.

Project M-202

Calcium Requirement of Young Turkeys

Tests to establish the calcium requirement of Maryland Medium White turkeys to 4 weeks of age have indicated that 1.0% to 1.4% calcium is adequate for growth and calcification. Bone ash was slightly lowered with 0.7% calcium. When the phosphorus level was barely adequate (0.5 to 0.55% "avail-

able phosphorus") bone ash also tended to be depressed when the calcium level was increased to 1.8%. Preliminary results also indicate that excessive levels of calcium tend to decrease growth slightly, as compared to that obtained with calcium levels of 1.0 to 1.4%.

Project M-206

Egg Production Gain by Selecting for High Levels of Alkaline Phosphatase

The purpose of this project is to see if egg production can be increased by breeding for differences in chemical level in blood serum. There is evidence that the level of alkaline phosphatase in blood serum is positively related to egg production. By selective breeding, a line has been developed with a level of this enzyme in serum three times that of a control line. This difference has been observed in the 6-week-old chickens as well as adults, even in birds as old as 2½ years.

Egg production of the high line has increased considerably, even though enzyme level was the only criterion for selection. The high line has also exhibited reduced body weight and minor changes in egg quality. These results suggest that alkaline phosphatase level can be used as an auxiliary tool in fowl selection for egg production. Such a procedure should be especially useful for screening males at an early age.

Project M-32-m

Chemical Basis for Genetic Differences in Susceptibility to Leucosis

Leucosis is a cancer-like disease that is one of the major killers of poultry. There is no effective control for leucosis, but mortality can be appreciably reduced by rearing growing stock separate from adults, and by breeding for resistance to the disease. Selection for resistance is widely practiced but is rather difficult for various reasons. The purpose of this project is to determine if the chemical basis for genetic differences in resistance is manifested in the level of an enzyme or enzymes in serum. If so, selection for increased resistance might be attained more easily by selection for changes in level of an enzyme.

Blood serum was obtained from a strain of chickens highly susceptible to leucosis and from another highly re-

sistant. The level of 13 enzymes was measured in the serum. Cathepsin was the only enzyme in which there was a consistent difference between strains. Level of this enzyme was markedly higher in the resistant strain than in the susceptible one. Cathepsin level was also measured in other strains known to differ in susceptibility to leucosis. In one comparison, cathepsin level was markedly higher in the resistant strain, but in a second comparison it was slightly lower. These results are all preliminary and inconclusive. Much additional data will be required to prove whether or not the level of an enzyme in serum is related to genetic differences in mortality from leucosis.

Project M-303 (NE-51)

Metabolic and Nutritional Studies of Microorganisms Important to the Poultry Industry.

Investigation of the nutritional requirements of the non-pathogenic "J" strain of the PPLO organism, reveal the need for several nutrients not previously known to be required. These substances, supplied in the growth medium as tryptic digest of casein, are thioctic acid, pantetheine (a form of pantothe-

nic acid) and the mineral ash of casein. The replacement of casein ash by known minerals has not yet been accomplished. Cholesterol with aleic and palmitic acids are widely known to be required. Other lipids may be stimulatory, as crude lipids increase growth over the pure lipids.

The study of lipid metabolism of *Tetrahymena* has shown that these single-cell, animal-like protozoa may not synthesize sterols in the same manner as mammals do. In the protozoa, triparanol (Mer 29) appears to block the ring closure of squalene (an intermediate in animal-cholesterol synthesis), whereas in mammals triparanol

blocks mainly the final step in cholesterol formation, at desmosterol. Triparanol also decreases the formation of tetrahymanol, the main non-saponifiable component of the protozoa.

These observations contribute to the increasing fund of knowledge on lipid metabolism in various species.

Project M-58

Relationship of Vitamin E to the Enlarged Hock

Disorder in Turkey Poults

Within recent years it has been established that enlarged hock disorder is a consistent feature of the zinc-deficiency syndrome in young turkeys. During this period an attempt was made to assess the effect of other deficiencies which had been reported primarily to cause enlarged hocks and other types of eprosis in turkeys. Biotin, choline and niacin deficiencies all were found to produce enlarged hocks, or perosis, even with adequate zinc in the diet. When vitamin E was left out of the diet, however, no enlarged hocks were encountered even though this vitamin has for many years been considered to

be required for normal hock development.

In view of this finding a more critical study of the role of vitamin E in preventing enlarged hocks has been undertaken. Maryland Medium White hens are being fed rations designed to produce eggs with a low vitamin E content so that the poults will be deficient in E when hatched. Several tests have been made with these "depleted" poults. Necrotic gizzards and other evidence of vitamin E deficiency has been encountered in these tests, but no enlarged hock disorder has been seen.

Effect of Folic Acid Supplementation of a Practical Type Turkey

Breeder Ration on Hatchability of Eggs and Quality of Offspring

On the basis of tests with Broad Breasted Bronze turkeys the minimum folic acid requirement for breeding rations has been suggested to be 0.35 mg per pound. During the first year of a study with Maryland Medium White hens fertility, hatchability of eggs, and

the livability and early growth rate of offspring did not differ from those on a practical type of breeder ration containing 0.3 mg, 0.48 mg or 0.83 mg of folic acid per pound.

Project M-62

Effects of Gonadal Hormones on Embryonic and Postnatal Bone Growth in Chickens

This project is a study to determine the effects on gonadal hormones on bone growth in immature domestic fowl. Three combinations of androgens and estrogens indicate that a definite synergistic effect is present, and hyperossification is intensified because of this effect. It has been possible to shorten the long bones of treated birds by approximately 10 percent, but there

is also a reduction in body size. Further data are being collected in order to determine whether or not the reduction in bone is independent of body-size decreases. Increases in body size under a regime of estrogenic treatment have been noted in females, but not in males.

Project M-64

Further Investigations Regarding Systemic Insecticides in Poultry

The problem of controlling external parasites of poultry, such as lice and mites, has been important, but it becomes of intense interest when a serious infestation occurs. Often, however, as more poultry are kept near populated areas, the problem of controlling flies from the manure becomes important to the poultryman for bird health. Also because of annoyance to his neighbors, it may assume public health aspects.

An additional three drugs were tested in the feed as systemic agents to determine effects upon the body louse as an example of an external parasite,

and the effect upon maggot and emerged fly numbers from the manure. The effect upon the bird was also studied, including feed consumption, body weight, egg production, and egg interior quality as measured by Haugh units.

While the drugs studied were tolerated well at comparatively high levels of feeding, the results as measured by the foregoing were not encouraging, and no residue studies in eggs or meat were made.

Project M-65

VETERINARY SCIENCE

Intensive research is essential to develop new knowledge for diagnosis and control of animal disease. Eradication of disease is the ultimate goal. Such research includes both fundamental and applied investigations. To achieve this goal, properly trained laboratory and field veterinarians, as well as other scientists, are needed in increasing numbers. Veterinarians engaged in private practice play an important role in developing scientific knowledge.

Present-day trends toward greater integration of animal production units, together with progressive breed improvement, enhance the value of the production enterprise and increase the need for disease control. The relation between diseases of animals and man constitutes a problem of paramount importance. Federal and State institutions work cooperatively in developing and carrying out programs for control and eradication of disease.

Respiratory Diseases of Poultry

In studies of Newcastle disease, the hemagglutination inhibition (HI) titers of individual chickens were determined as an indication of response to multiple vaccinations. These tests showed an increase in titer following administration of live N-75 Newcastle disease vaccine to immune chickens. Susceptible birds receiving the same vaccine responded with titers. No evidence of spread of the vaccine was seen. Contact controls remained negative to the HI test and succumbed to challenge.

Attempts to evaluate the importance of antigenic variants of the infectious bronchitis virus (IBV) were continued. Sixteen field strains of IBV failed to produce symptoms or lesions in chickens immunized to the Massachusetts type of IB virus.

Research on Gumboro-Nephrosis syndrome has revealed an agent which appears unrelated to IB. The typical disease can be produced in birds immunized against IB and ND. The agent can be readily demonstrated in liver suspensions from affected birds or by oral or parenteral inoculation of susceptible chickens.

Titration of *Mycoplasma gallisepticum* (PPLO), the casual agent of

chronic respiratory disease, were made in chickens, turkeys, and phenol red dextrose broth (Difco) enriched with 10% swine serum. Experimental birds were inoculated by air sac and intranasal routes. The birds were checked at 7-day intervals by the rapid serum plate agglutination test, for PPLO antibodies. The inoculum prepared for titration consisted of turkey sinus exudate diluted in the phenol red serum broth.

Chickens, on the basis of the studies, appear to be as susceptible to PPLO as turkeys. The air sac route in chickens is more sensitive than intranasal inoculation. Either route was effective for the turkey. Bird inoculation was ten times as sensitive as phenol red dextrose swine serum broth for detection of PPLO.

Complement-fixation tests, using avian complement and hemolysin, were studies. No fixation in the presence of heat-inactivated positive serum and PPLO antigen could be demonstrated. Fresh serum appeared to fix complement on several occasions, but interpretation was difficult, as proper controls could not be devised.

Project D-52, NE-5

Equine Encephalitis

For the second consecutive year, there were no laboratory-confirmed cases of eastern equine encephalitis in Maryland. Various age groups of chickens inoculated with live EEE virus and vaccine were used in an experiment designed to study serologic response and viremia levels. Results indicate that viremia persists longer with an increase in age at the time of inoculation, when higher antibody levels are attained.

Of the 33 different lines of tissue culture used in an attempt to propagate Guaroa virus, only 6 were found to show cytopathic effect upon inoculation with Guaroa virus. Characterization of this virus included pathogenesis for the burro, rabbit, chicken and mouse, and also thermal stability, RNA determinations and fluorescent antibody studies. The BeAr 7272 strain of Cache Valley virus was inoculated into burros and chicks. No viremia was demonstrable in burros or the day-old chick. Serologic response in 2-week-old chicks was not detectable, but HAI response in burros was significant. The cell lines, BEK, and WI-26, were used suc-

cessfully in propagating the virus. The laboratory, situated on Wallop's Island and maintained cooperatively with WRAIR, collected serum samples from the pony herd on Assateague Island for serologic analysis. Over 25,000 mosquitoes were collected for virus isolation.

Burros, previously subjected to multiple exposure to Group A arboviruses, were challenged with Chikungunya virus to determine its effect on the broad spectrum response already elicited. Rise in antibody titer was demonstrable for the challenge only. Burros having had previous experience with EEE, WEE and Sindbis viruses were challenged with WEE virus. Only those burros having been exposed to EEE and WEE viruses responded serologically to the WEE virus challenge.

Reinfection of a horse, using mosquitoes infected with JE virus, was attempted with little success. No circulating virus could be detected and evaluation of the serologic response awaits completion of the tests.

Project D-57

Bovine Mastitis

An investigation was made to determine the use of tetrazolium salts in a rapid screen test and antibiotic sensitivity test for bacteria in milk. Bulk milk samples and individual quarter samples were tested from 65 herds. The reduction of the tetrazolium salt to a colored formazan was irregular in time for bacteria counts of 50-100 thousand bacteria/ml in bulk milk; and, therefore, the test was not useful for detecting high bacteria counts in these samples. The individual quarter samples were found to contain too low a bacteria count for rapid detection in a screen test.

Tetrazolium salts were added to Mueller Hinto medium containing 10% horse serum for use in a rapid antibiotic sensitivity test. Sensitivity results were detected with streptococci in 2 to 4 hours. Irregular results were given by the hemolytic staphylococci. Since approximately 50% of all infectious mastitis is caused by hemolytic staphylococci, this test was not found to be useful for mastitis sensitivities.

In a general control survey, 75 herds containing 3,367 cows, were cultured for mastitis. Of the 9,407 individual quarter samples, 35.5% were positive on culture. The percentage of the type

of infection were as follows: 15.2% for hemolytic staphylococci, 19.8% for

streptococci, and 5% with other organisms. *Project D-58*

Air-Sac Infection in Poultry

Air-sac infection was the cause for 38% of the total condemnations of poultry carcasses in the slaughter house in 1963, according to information received from the Poultry Inspection Branch of the Agricultural Marketing Service. In carcasses showing evidence of air-sac infection, the location and nature of disease lesions determines whether the whole carcass or only a part of it must be rejected as unwholesome for human consumption.

Although air-sac infection primarily affects the respiratory system of the fowl, on some occasions the disease also has been found in other parts of the body. Further studies on pathogenesis and distribution in the carcass of the usual organism, *Mycoplasma gallisepticum* (PPLO), therefore, are being carried out to determine to what extent infection may be spread through the body.

In carrying out current investigation, turkeys were inoculated artificially with *M. gallisepticum*, strain S₆, and autopsied at various intervals after inoculation. Organs and tissues from wide-separated parts of the carcass are removed aseptically and examined for PPLO. Because growth of *M. gallisepticum* in laboratory media is time consuming and attended with certain difficulties, fluorescent staining of tissues after culture also is employed as an alternate and more rapid method of identifying the causal organism. For detection of PPLO by culture, tissues were macerated and seeded in phenol-red broth containing 2% PPLO serum fraction (Difco), 1% glucose and thiamine acetate (1 to 2,000). Beef-heart

infusion agar plates containing 4% PPLO serum fraction also was employed. For detection by fluorescent staining, immune serum produced in rabbits was conjugated with fluorescent isothiocyanate. Flazo-orange was used as a counter stain. Smears from staining were prepared, both by tissue impressions and fixation of tissue macerates. Tissue samples were taken from abdominal and diaphragmatic air sacs, lungs, trachea, spleen, heart, kidney, brain, and smears from the blood. Also, from intercostal, triceps, biceps, brachii, and gastrocnemius muscles. Each tissue sample was divided in half and each part examined for causal organisms by each method. The inoculated turkeys were bled before autopsy and the serum subjected to the tube agglutination test with homologous antigen.

All inoculated turkeys were found positive to the agglutination test. In some instances, serum was positive 5 days after inoculation. In a high percentage of the tissue found to contain PPLO, the organism was identified both by culture and by fluorescent staining. In 1 tissue out of 80, the organism was identified by fluorescent staining, but was not detected by culture. In 4 tissues, the causal organism was identified by culture when fluorescent staining had failed. *M. gallisepticum* was found in the circulating blood 11 days postinoculation. The tendency for PPLO to spread to tissues outside the respiratory system was further shown by isolations from intercostal muscles, kidneys, and, in one instance, from the heart.

Project D-59

Infectious Diseases Affecting Reproduction in Cattle, with Special Reference to Vibriosis and Leptospirosis

Vibriosis. Conjugated fluorescent antisera have been produced from rabbits against *Vibrio fetus* types I, II and IV. The reproducibility of a biotyping system has been checked on 101 cultures of all four types of *Vibrio* and classification disagreement was markedly significant. Evaluation of a modified technique for optimum staining and differentiation of strains has shown encouraging results. The possibility of eradication of vibriosis in the bull stud has come closer to reality due to successful rapid methods of diagnosis coupled with encouraging results in treatment of male carriers.

Leptospirosis. Herd surveys furnished additional evidence that serotypes other than pomona predominate in Maryland. The response of calves to sequential exposures indicates that canicola may protect against ballum and pomona, but not wolffi infection. The

spectrum of serologic response did not increase with these exposures. Eleven of twelve sheep, protected by previous exposure to *L. canicola* or *L. pomona*, were resistant to exposure to the homologous or heterologous hemolysin. Previous exposure to *L. hardjo* gave no such protection against canicola or pomona hemolysin.

Immunologic response of cows to pomona vaccination and calves to sequential exposure to different serotypes has helped to evaluate diagnostic serology and the protective effect of vaccination against the several strains serologically important in Maryland. The role of certain hemolysins in the pathogenesis of leptospiral infections has been demonstrated and initial experiments indicate that protection against one hemolysin affords protection against other hemolytic strains.

Project D-62, NE-40

Study of Bovine Respiratory Diseases

Outbreaks of suspected bovine respiratory diseases have been investigated in Maryland and the clinical specimens collected from the affected animals examined. The findings indicate that shipping fever and infectious bovine rhinotracheitis (IBR) have been prevalent in Maryland cattle during the past year.

An experiment was conducted to study the resistance of calves immunized against bovine myxovirus parainfluenza-3 (SF-4). The results indicated that the formula-killed virus vaccine with adjuvant added is capable of inducing solid immunity against shipping fever.

Characteristics of hemadsorbing enteric (HADEN) virus have been studied and the virus has been found to be resistant to ether desoxycholate and to a wide range of pHs. By fluorescent microscopy and growth in the presence of IUDR, it has been demonstrated that this virus has RNA as its nucleic acid complex, multiplies both in the cytoplasm and nucleus of the cell, and produces intranuclear inclusion bodies. Preliminary experimental infection of calves with this virus has been unsuccessful. The virus is prevalent in 76% of the Maryland cattle population.

A serum neutralization test for IBR

has been standardized. The results were reproducible and the test was accurate to less than a 3-fold dilution error.

Infectious RNA from reovirus type 1 has been successfully extracted with

phenol and its infectivity has been assayed in bovine embryonic kidney-cell cultures. Compared with the whole virus, there was a slight drop in infectivity with the RNA fraction of the virus.

Project D-63

Studies on Cultivation of Avian Respiratory Viruses in Tissue Culture

The infectious laryngotracheitis virus (ILT) causes a wide-spread and serious disease in chickens. Propagation of this viral pathogen in tissue culture promises certain advantages over the older methods of cultivation in embryonating chicken eggs, or in the trachea of susceptible chickens. Further study on the mode of replication in cell culture is needed.

In the present investigation, cell cultures were prepared from young chicken kidney tissue. After removing segments of the organ aseptically from a freshly killed and partially exsanguinated carcass, tissue was minced and trypsinized by the standard method. The cells were then washed and adjusted to a concentration of 5×10^5 cells per ml of Eagle's Basal medium containing Earl's balanced salts and enriched with 10 per cent calf serum and glutamine (2mM). After 48 to 72 hr incubation (37 C), when a cell sheet was well formed, a 10^{-1} dilution of ILTV, titring 10^{-6} in tissue culture, was placed in each culture tube after removing the original culture medium. The infected cell culture was permitted to absorb virus at 37 C for 3 hr. After which the cells were washed repeatedly to remove nonabsorbed virus, supplied with fresh medium and returned to the incubator. The growth period for virus replication was calculated from the time virus was introduced. Infected cells were removed

from culture tubes at progressive intervals from zero to 42 hr. and examined for viral antigen by fluorescent staining.

The stain was prepared by conjugating ILT immune serum with fluoresceine isothiocyanate and employed with flazo-orange as a counter stain. Immune serum was obtained by exsanguinating chickens 3 weeks after intratracheal inoculation. It had an index of 10^3 to 10^4 as determined by serum neutralizing tests, both in cell culture and embryonating chicken eggs. In cell cultures examined 6 hr postinoculation, viral antigen was first detected on the inside of the nuclear membrane. At 9, 12, and 18 postinoculation, viral antigen had become more abundant, becoming dispersed through the nucleus with greatest concentration near (but not in) the nucleolus. After 30 hr, the cell culture exhibited cytopathogenic effect of the syncytial type and viral antigen was present in the cytoplasm. A second cycle of cell invasion was observed after a growth period of 42 hr as indicated by the presence of viral antigen concentrated on the inside of the nuclear membrane in cells not previously infected.

Repeated attempts also were made to isolate infectious nucleic acid from two other avian viruses. These were the Newcastle and infectious bronchitis viruses. These viruses were propagated

in young chicken kidney-cell culture and concentrated from fluid medium by centrifugation at $30,800 \times G$ for 2 hr. Concentrated virus was resuspended in phosphate buffer in a concentration titering $10^{-7.8}$ in cell culture. Concentrated virus was extracted with 80 per cent cold phenol (4 C) and an attempt made to precipitate infectious nucleic acid with 67 per cent ethanol. The ethanol precipitate was divided in two parts. One was inoculated in cell cul-

ture which subsequently were observed for cytopathogenic effect. The other was treated with RNase as a control to destroy any infectious nucleic acid present in the precipitate and inoculated in cell cultures. All attempts to isolate infectious nucleic acid from these two myxoviruses by this method failed and, in this respect the results are consistent with the findings of some other investigators.

Project D-64

Etiology and Pathogenesis, Laboratory Diagnosis and Chemotherapy of Bovine Lymphosarcoma

A study of bovine lymphosarcoma (BLS), the most common form of bovine leukemia, was started in this laboratory in 1957, when a bovine fetus, which was expelled during the 8th month of pregnancy by a cow with a normal blood picture and clinically healthy, showed metastatic lymphosarcoma nodules in all inner organs, including the brain.

In an attempt to induce bovine leukemia in experimental animals, 36 one-day-old calves and 1,047 new-born white Swiss mice were administered BLS materials during the last 3 years. Twelve of these calves were in the original group inoculated with either emulsion, sonicated extracts, or tissue cultures derived from BLS masses. The inoculations were administered through various routes—cerebrum, jugular vein, peritoneum, and thymus area. Four of the calves were administered BLS extracts orally through their milk. This portion of the study is of the utmost significance in view of the tremendous danger to public health that would result if the leukemic agent were transmissible to humans through the milk.

Some of the calves were inoculated with material taken from one of the mice which developed leukemia 145 days after i/c inoculation with BLS. Still other calves were inoculated with extracts of lymph nodes obtained by biopsies from two of the calves originally inoculated with BLS and which had now developed lymphocytosis. In addition, calves were inoculated with cell-free extracts of tissue cultures in which a cytopathogenic effect (CPE) was produced with the plasma of two calves previously inoculated with BLS and which had developed lymphocytosis and suspicious clinical manifestations of BLS. Ten calves, not inoculated, and two, inoculated with inactivated material, were used as control.

With the exception of two, the inoculated calves, to date, have developed various degrees of lymphocytosis, some with immature forms of lymphoid cells. A marked lymphocytosis (over 12,000 circulating lymphoid cells/cmm) is considered to be either an early or subclinical stage of leukemia. Of the 4 calves administered BLS extracts orally through the milk for 2 to 3 weeks 3 had a positive blood reaction. Two

of the 3, in addition, showed suspicious clinical manifestations, such as swelling of the submaxillar and cervical lymph nodes and hypertrophic thymuses.

Among the inoculated mice, a small percentage (0.96-2.39%) developed lymphoid leukemia and a higher percentage (4.76-13.3%), breast tumors (adenocarcinomas). In addition, other possibly related conditions, such as leukemoid disease, splenomegaly, and lymph node hyperlasia, were observed. These results are similar to those observed in small experimental animals injected with human leukemic materials. However, there was a loss of oncogenic potentialities through consecutive passages among the mice. This

may indicate that either the agent is strain specific or that the mice used were fairly resistant to bovine leukemia. On the other hand, the incidence of leukemia was greater in the offspring of mice (up to the 3rd generation), the parents of which had been originally inoculated with BLS extracts. This is explainable if it is assumed that the agent can participate in genetic conjugations.

Since leukemia naturally occurs mostly in aged cattle (maximum incidence usually during the 8th year), the inoculated animals are still too young to permit definite conclusions regarding the possibility of inducing bovine leukemia.

Project D-65

Toxic Substances Produced by the Mold, *Stachybotrys atra*

Moldy feeds have long been suspected as a source of animal illness, but, until recently, except in the case of ergot poisoning, there has been little scientific basis for these suspicions. During the past few years, mold poisons—mycotoxins—have been shown to be the cause of serious losses of farm animals. Recent studies at this Experiment Station have indicated that *Stachybotrys atra*, growing in litter may produce substances causing lesions of the mouth and crop of chicks.

These toxins have been obtained only

in crude extracts. This project is an attempt to isolate and purify the toxins in order that their effects may be better observed. The chemical nature of the substances involved is unknown. Much of the inert material has been removed from the crude extract by n-heptane extraction of the material adsorbed on alumina. The toxic material, which causes severe irritation when applied to the skin of rabbits, was then recovered by extraction with ethyl alcohol.

Project D-66

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1963-1964

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Agricultural Engineering

R. L. Green, Ph.D., Prof. and Head
George Burkhardt, M.S., Res. Prof.
K. E. Felton, M.S., Assoc. Prof.
G. W. Gienger, M.S., Assoc. Prof.
W. L. Harris, Ph.D., Asst. Prof.
P. V. Matthews, Jr., M.S., Asst. Prof.
P. N. Winn, M.S., Assoc. Prof.

Agronomy

J. R. Miller, Ph.D., Assoc. Prof. of Soils and Head
J. H. Axley, Ph.D., Assoc. Prof. Soils
N. A. Clark, Ph.D., Asst. Prof. Crops
A. M. Decker, Jr., Ph.D., Assoc. Prof. Crops
J. H. Hoyert, Ph.D., Assoc. Prof. Tobacco
C. B. Kresge, Ph.D., Asst. Prof. Soils
J. A. Meade, Ph.D., Asst. Prof. Crops
J. A. Pomeroy, Ph.D., Asst. Prof. Soils
R. G. Rothgeb, Ph.D., Res. Prof. Crops
O. E. Street, Ph.D., Prof. Tobacco
Edward Strickling, Ph.D., Assoc. Prof. Soils

Animal Science

J. E. Foster, Ph.D., Prof. and Head
John Buric, Ph.D., Assoc. Prof.
W. W. Green, Ph.D., Prof.
E. C. Leffel, Ph.D., Assoc. Prof.
E. P. Young, Ph.D., Asst. Prof.

Botany

R. W. Krauss, Ph.D., Prof. Plant Phys. Head
Ronald Bamford, Ph.D., Dean Grad. Sch. Prof.
A. A. Bell, Ph.D., Asst. Prof. Plant Path.
R. A. Galloway, Ph.D., Asst. Prof. Plant Phys.
H. G. Gauch, Ph.D., Prof. Plant Phys.
W. L. Klarman, Ph.D., Asst. Prof. Plant Path.
L. R. Krusberg, Ph.D., Asst. Prof. Plant Path.
J. D. Lockard, Ph.D., Asst. Prof. Bot. and Education
D. T. Morgan, Jr., Ph.D., Prof. Bot.
O. D. Morgan, Jr., Ph.D., Assoc. Prof. Plant Path.
R. A. Paterson, Ph.D., Assoc. Prof. Bot.

R. D. Rappleye, Ph.D., Assoc. Prof. Bot.
H. D. Sisler, Ph.D., Assoc. Prof. Plant Path.
F. J. Williams, Ph.D., Asst. Prof. Plant Path.

Dairy Science

R. F. Davis, Ph.D., Prof. and Head
Wendell Arbuckle, Ph.D., Prof. Dairy Mfg.
J. L. Cason, Ph.D., Assoc. Prof. Dairy Sc.
R. N. Doetsch, Ph.D., Prof. Microbiology
R. W. Hemken, Ph.D., Assoc. Prof. Dairy Sc.
Mark Keeney, Ph.D., Prof. Dairy Mfg.
R. L. King, Ph.D., Assoc. Prof. Dairy Mfg.
J. F. Mattick, Ph.D., Assoc. Prof. Dairy Mfg.
W. E. Stewart, Ph.D., Asst. Prof. Dairy Sc.
J. H. Vandersall, Ph.D., Asst. Prof. Dairy Sc.
W. F. Williams, Ph.D., Asst. Prof. Dairy Mfg.

Editorial

Roy E. Miller, B.S. in Journalism, Editor
W. B. Neff, Ph.D., Editor

Entomology

W. E. Bickley, Ph.D., Prof. and Head
G. J. Abrams, M.S., Asst. Prof. Apiculture
L. P. Dittman, Ph.D., Prof.
Castillo Graham, Ph.D., Assoc. Prof.
F. P. Harrison, Ph.D., Asst. Prof.
J. C. Jones, Ph.D., Assoc. Prof.
E. R. Krestensen, Ph.D., Asst. Prof.
Allen Steinhauer, Ph.D., Asst. Prof.

Home Economics

Pela F. Braucher, M.S., Assoc. Prof. Foods and Nutrition

Horticulture

F. C. Stark, Jr., Ph.D., Prof. Veg Crops & Head
W. L. Hollis, Ph.D., Assoc. Prof. Veg. Crops
Amihud Kramer, Ph.D., Prof. Hort.
C. B. Link, Ph.D., Prof. Flor.
W. A. Matthews, M.S., Assoc. Prof. Veg. Crops
C. W. Reynolds, Ph.D., Assoc. Prof. Veg. Crops
L. E. Scott, Ph.D., Prof. Hort. Phys.
J. B. Shanks, Ph.D., Prof. Flor.
R. J. Snyder, Ph.D., Assoc. Prof. Veg. Crops
A. H. Thompson, Ph.D., Prof. Pomol.
R. C. Wiley, Ph.D., Assoc. Prof. Hort. Processing

Poultry Science

C. S. Shaffner, Ph.D., Prof. and Head
G. F. Combs, Ph.D., Prof. Poultry Nut.
R. D. Creek, Ph.D., Assoc. Prof. Poultry Sc.
N. V. Helbacka, Ph.D., Assoc. Prof. Poultry Mktg.
G. D. Quigley, B.S., Assoc. Prof. Poultry Sc.
Mary S. Shorb, Sc.D., Res. Prof. Poultry Nut.
W. C. Supplee, Ph.D., Res. Assoc. Poultry Nut.
F. H. Wilcox, Ph.D., Assoc. Prof. Poultry Sc.

Veterinary Science

T. A. Ladson, D.V.M., Dir. L.S.S.C. and Head
A. C. Brown, V.M.D., Asst. Prof.
H. M. DeVolt, B.S., D.V.M., M.S., Prof. Avian Path.
B. C. Hatzios, D.V.M., D.A.H., Assoc. Prof. Path.
R. B. Johnson, A.B., Assoc. Prof. Vet. Sc.
S. B. Mohanty, D.V.M., Asst. Prof.
R. B. Shilling, D.V.M., Asst. Prof.
Elizabeth J. Shultz, V.M.D., Asst. Prof.

FINANCIAL STATEMENT — JULY 1, 1963 TO JUNE 30, 1964

Federal Funds

	Amended Hatch	Regional Research	Agrl. Marketing Title II	Forestry McIntire-Stennis
<i>Appropriation 1963-1964</i>	\$427,007.00	\$127,799.00	\$8282.96	\$15,558.00
TOTALS	\$427,007.00	\$127,799.00	\$8282.96	\$15,558.00
<i>Receipts from sources other than Federal 1963-1964</i>				
State Appropriations for Agricultural Investigation.....				<i>For Agric. Investigations*</i> \$1,357,824.63
Special Endowments, Fellowships and Grants.....				47,269.21
Sales and Miscellaneous.....				165,929.75
Total				\$1,571,023.59
Balance brought forward July 1, 1963.....				58,012.51
TOTAL				\$1,629,036.10

Expenditures:

Personal Services.....	\$288,294.63	\$ 78,969.48	\$3,800.04	\$ 85.24
Travel & Transportation of Persons.....	4,445.66	4,579.41	495.35	
Equipment.....	40,430.70	19,650.69	166.50	2,392.36
Lands & Structures.....	752.55			649.43
Personal Benefits.....				
Supplies & Materials.....	78,872.90	21,769.92	297.03	844.92
All Other.....	14,210.56	2,829.50	369.97	534.00
TOTAL	\$427,007.00	\$127,799.00	\$5,128.89	\$ 4,505.95
Balance June 30, 1964.....			3,154.07	11,052.05
TOTALS	\$427,007.00	\$127,799.00	\$8,282.96	\$15,558.00

*Including Offset Funds

PUBLICATIONS

Bulletins

- A130 The Influence of Added Calcium Salts on the Texture of Thermal Processed Apple Slices. J. L. Collins and R. C. Wiley. 62 pp. December, 1963.
- A131 Developmental Anatomy of Vascular Tissues in the York Imperial Apple, with Special Emphasis on the Pedicel. J. A. Barden and A. H. Thompson. 53 pp. October, 1963.
- A132 Evaluation of Factors Influencing Pesticide Deposits on Leaf Surfaces. J. R. Young and L. P. Ditman. 36 pp. December, 1963.
- A133 Research Leads to Progress of Maryland Agriculture. (75th Annual Report for the Maryland Agricultural Experiment Station) I. C. Haut. 98 pp. June, 1963.
- A134 The Effect of Apholate on the Southern House Mosquito, *Culex pipiens quinquefasciatus* Say. W. S. Murray and W. E. Bickley. 37 pp. November, 1964.
- A135 Effect of Methods and Rates of Fertilizer Application on Growth and Development of Maryland Tobacco. J. D. Bowling and David Wilson. 26 pp. July, 1964.

Scientific Journal Articles and Miscellaneous

Periodicals, Reports, Proceedings, Etc.

Department of Agricultural Economics

- 489 Level and Variability of Maryland Farm Product Prices, 1910-62. J. W. Wyson. Multigraphed Circular. 58 pp. August, 1963.
- 490 Agricultural Production and Consumption Patterns—Market Potential in Thailand. H. D. Smith. Multigraphed Circular. 98 pp. July, 1963.
- 492 The Market Structure and Use of Labor in Maryland Tobacco Auction Warehouses. G. M. Beal and R. M. Jones. Multigraphed Circular. 74 pp. December, 1963.
- 493 Some Features of the Maryland Sales Tax Law with Special Reference to Agriculture. W. P. Walker. Multigraphed Circular. 16 pp. August, 1963.
- 515 The Effects of Changes in Transportation Rates on the Delmarva Poultry Industry. J. E. Martin. Multigraphed Circular. 102 pp. May, 1964.
- 518 The Role of Meat Buying Specifications in Contract Livestock Production in Maryland. H. D. Smith. Multigraphed Circular. 29 pp. 1964.
- 519 Effect of Vining Method on Cost of Processing Lima Beans. D. A. Swope and R. S. Fox. Multigraphed Circular. 45 pp. June, 1964.
- 522 Assessing Farm Land Under Maryland's Use Value Assessment Law. W. P. Walker and W. D. Gardner. Multigraphed Circular. 27 pp. June, 1964.
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Department of Agronomy

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- A1079 Improved Soil Openers for the Establishment of Small-Seeded Legumes in Sod. A. M. Decker, H. J. Retzer and G. F. Swain. Agron. Jour. 56:211-214. 1964.
- A1083 Nitrogen Fertilization of Forage Mixture Containing Differential Legume Percentages. C. B. Kresge. Agron. Jour. 56:325-328. 1964.
- A1101 Pseudo-self-compatibility and Segregation of Gametophytic Self-incompatibility Alleles in White Clover, *Trifolium repens* L. M. M. Cohen and R. C. Leffel. Crop Sci. 4:429-431. 1964.
- 514 The Performance of Hybrid Corn, 1961-63. R. G. Rothgeb. Multigraphed Circular. 20 pp. May, 1964.

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- A1091 Effectiveness of Punches Truss Plates. K. E. Felton and H. D. Bartlett. (Presented at Bldg. Res. Institute Fall Meeting, November 19-21, 1963).
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- 521 Principles and Management for Curing Maryland Tobacco. P. N. Winn, Jr., and C. G. McKee. Multilithed Circular. 13 pp. November, 1964.

Department of Botany

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- A1084 Site of Action of Cycloheximide in Cells of *Saccharomyces pastorianus*. I. Effect of the Antibiotic on Cellular Metabolism. M. R. Siegel and H. D. Sisler. Biochimica et Biophysica Acta. 87:70-82. 1964.
- A1085 Site of Action of Cycloheximide in Cells of *Saccharomyces pastorianus*. II. The Nature of Inhibition of Protein Synthesis in a Cell Free System. M. R. Siegel and H. D. Sisler. Biochimica et Biophysica Acta. 87:83-89. 1964.
- A1093 Aging at the Cellular Level. Constantine Sorokin. Experientia 20:353. 1964.
- A1099 Influence of Plant Growth Regulating Substances on Reproduction of *Ditylenchus dipsaci*, *Pratylenchus penetrans* and *Pratylenchus zeae* on Alfalfa Tissue Culture. L. R. Krusberg and Maxine L. Blickenstaff. Nematologica, 10:145-150. 1964.
- A1107 Uptake of Cycloheximide by a Sensitive and a Resistant Yeast. E. W. Wescott and H. D. Sisler. Phytopath 54:1261-1264. 1964.
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- A1137 Occurrence and Control of a Nematode of the Genus *Hypoperine* on *Zoysia* and Bermuda Grasses in Maryland. A. A. Bell and L. R. Krusberg. Plant Dis. Reporter 48:721-722. September, 1964.
- 491 Control of Cucumber Scab on the Eastern Shore of Maryland. J. G. Kantzes, L. O. Weaver and J. M. Wells. Plant Dis. Reporter 47(9):802-804, September 15, 1963.
- 509 Effect of Fungicidal Sprays on Disease Control and Yield of Cantaloupes on the Eastern Shore of Maryland, 1963. J. G. Kantzes. Trans. Penin. Hort. Soc. 53(5):51-54. 1963.
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- 523 Experimental Infection of *Nicotinae* Species and Interspecific Crosses with *Cercospora nicotiana* and *Cercospora kikuchii*. O. D. Morgan. Plant Dis. Reporter 48(9):693-695. 1964.
- 524 The Occurrence of a Sclerotinia on *Vicia villosa* in Maryland. O. D. Morgan. Plant Dis. Reporter 48(9):696-697. 1964.

Department of Dairy Husbandry

- A1015 Development of Domestic Feta Cheese. J. F. Mattick and C. C. Efthymiou. Jour. Dairy Sci. XLVII(6):593-598. June, 1964.
- A1027 Use of p-Phenylazobenzoyl Chloride for the Chromatographic Analysis of Fatty Alcohols. Ira Katz and Mark Keeney. Analytical Chem. 36(1):231-234. January, 1964.
- A1075 Ruminant Carbonate as a Precursor of Eructed Methane and Carbon Dioxide. W. F. Williams, H. Hoernicke, D. R. Waldo, W. P. Flatt and M. J. Allison. Jour. Dairy Sci. 46(9):992-993. September, 1963.
- A1087 The Isolation of Fatty Aldehydes from Rumen Microbial Lipids. Ira Katz and Mark Keeney. Biochemica et Biophysica Acta. 84:128-132. 1964.
- A1090 Metabolism of Albumin-Bound Palmitate-1-C¹⁴ by the Isolated Perfused Goat Liver. J. D. Connolly, H. H. Head and W. F. Williams. Jour. Dairy Sci. 47 (4):386-390. April, 1964.
- A1120 An Abomasal Fistula Technique for Calves. W. E. Stewart and J. H. Nicolai. Jour. Dairy Sci. XLVII(6):654. June, 1964.
- A1121 Depletion of Strontium from Calves by Hemodialysis. H. F. Downey, W. E. Stewart and R. G. Cragle. Trans. Am. Soc. Art. Int. Organs. X:350-352. 1964.
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- A1132 Effect of Hay to Grain Ratio of the Utilization of Metabolizable Energy for Milk Production by Dairy Cows. C. E. Coppock, W. P. Flatt, L. A. Moore and W. E. Stewart. Jour. Dairy Sci. 47:1330-1338. 1964.
- A1135 Feed and Animal Factors Affecting Salivation and Its Relation to Bloat. R. M. Meyer, E. E. Bartley, J. L. Morrill and W. E. Stewart. Jour. Dairy Sci. 47:1339-1345. 1964.
- 508 The Effect of Some Mild Alkaline Salts on the Properties of Ice Cream. W. S. Arbuckle. Mimeo. Cir. 10 pp. March, 1964.

Department of Entomology

- A1057 Life History of *Asphondylia ilicicola* (Diptera: Cecidomyiidae), a Pest of American Holly. H. A. Highland. Jour. Econ. Entomol. 57(1):81-83. 1964.
- A1060 An Evaluation of the Effectiveness of Nine Insecticides Against Vegetable Pests. R. G. Dent and L. P. Ditman. Jour. Econ. Entomol. 57(1):177-178. February, 1964.
- A1104 The Genus *Abgrallaspis* in North America (Homoptera: Diaspididae). J. A. Davidson. Annals Entomol. Soc. Amer. 57(5):638-643. September, 1964.
- A1105 Experiments with Granular Formulation of Systemic Insecticides in the Soil at Time of Planting. M. F. Littleford, C. J. Eckenrode and L. P. Ditman. Trans. Penin. Hort. Soc. 53(5). 4 pp. 1963.
- A1106 The Effect of Temperature on Hatching of Egg of the Mosquito *Culex pipiens quinquefasciatus* Say. David Shriver and W. E. Bickley. Mosquito News 24(2):137-140. June, 1964.
- 497 Locality Records and a Host Plant for the Stinkbug *Edessa florida* Barber. T. L. Bissell. Proc. Entomol. Soc. Wash. 66(4):119-120. June, 1964.
- 498 Experiments with Concentrate Sprayers. E. R. Krestensen and Castillo Graham. Trans. Penin. Hort. Soc. 53(5). 8 pp. 1963.
- 500 Control of Orchard Mites. Castillo Graham and E. R. Krestensen. Trans. Penin. Hort. Soc. 53(5). 2 pp. 1963.
- 506 Observations on *Drosophila* Populations in Early Spring. W. E. Bickley and R. A. Berry, Jr. Trans. Penin. Hort. Soc. 53(5). 2 pp. 1963.

Department of Horticulture

- A1095 Preliminary Field Evaluation of Carbamates on Horticultural Crops. Dorothy A. White and J. D. Rigglesman. Proc. N. E. Weed Control Conf. 18:90-95. January 8, 1964.
- A1096 Preliminary Field Evaluation of Herbicides on Horticultural Crops. J. D. Rigglesman and Dorothy A. White. Proc. N. E. Weed Control Conf. 18:53-61. January 8, 1964.
- A1097 Incorporation of Trifluralin in Snap Beans, Soybeans and Cantaloupes. J. D. Rigglesman and J. A. Meade. Proc. N. E. Weed Control Conf. 18:97-99. January 8, 1964.
- A1098 Herbicide Effects on Newly Established Strawberry Plants and Subsequent Fruit Production. G. J. Stadelbacher, J. D. Rigglesman and D. A. White. Proc. N. E. Weed Control Conf. 18:140-147. January 8, 1964.
- A1114 Rooting Depths and Water Use by Vegetable Crops. C. W. Reynolds and R. J. Adkins. Trans. Penin. Hort. Soc. 53:7-20. 1964.
- 447 The Role of Raw Product Quality in Planning Inventories of Processed Foods. Amihud Kramer. Canning Trade 86(16):6-9 and 86(17):40-43. February 10 and 24, 1964.
- 469 Definition of Texture and Its Measurement in Vegetable Products. Amihud Kramer. Food Technol. 18(2):46-49. 1964.
- 471 Quality Control Improves Pack Yields of Sweet Corn. B. A. Twigg. Food Tech. 18(2):62-65. 1964.
- 496 Plant Food Requirements as Related to Plant Development: The Implication in Fertilizer Placement Research. F. C. Stark. Natl. Plant Food Council Report. Multigraphed Circ. 8 pp. 1963.
- 499 Making the Most of Hydrangeas. J. B. Shanks and C. B. Link. The Maryland Florist 103. 11 pp. December, 1963.
- 501 Promising New Chemicals for Weed Control. J. D. Rigglesman. Proc. N. E. Weed Control Conf. 18:14-20. January 8, 1964.
- 503 Snap Bean Variety Study—1963. W. L. Hollis. Mimeographed Circular, 22 pp. November, 1963.
- 504 Sweet Corn Variety Study—1963. W. L. Hollis. Mimeographed Circular, 28 pp. January, 1964.
- 505 Growth Habits and Training of Spur Type Delicious Apple Trees. B. L. Rogers. Md. Fruit Grower 34(1):8-10. February, 1964.
- 520 The Chemical Regulation of Plant Growth For Florists. J. B. Shanks and C. B. Link. Md. Florist 108. 16 pp. May-June, 1964.

Department of Poultry Science

- A1058 Effect of Coccidiosis on Different Glands of the Growing Chick. B. Panda and G. F. Combs. Avian Dis. VIII(1):7-12. February, 1964.
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- A1067 Studies on Coccidiosis and Vitamin A Nutrition of Broilers. B. Panda, G. F. Combs and H. M. DeVolt. Poultry Sci. 43(1):154-164. 1964.
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Department of Veterinary Science

- A1048 Clinical and Immunologic Interrelationship Among Venezuelan, Eastern, and Western Equine Encephalomyelitis Viruses in Burros. R. J. Byrne, C. French, W. S. Gochenour, F. S. Yancey and E. L. Buescher. Amer. Jour. Vet. Res. 25(104):24-31. 1964.
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- A1069 A Fluorescent Antibody Study of Infectious Bronchitis Virus. S. B. Mohanty, H. M. DeVolt and J. E. Faber. Poultry Sci. 43(1):179-182. 1964.
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CURRENT PROJECTS

(These are projects and not publications available to the public)

Department of Agricultural Economics

Project

- A-18-as An Analysis of Past, Present and Prospective Levels and Variability of Prices of Maryland Farm Products and Farm Resources. J. W. Wysong.
- A-18-at The Acquisition and Use of Capital on Large Farms in Selected Type-of-Farming Areas in Maryland. R. A. Murray.
- A-18-av An Analysis of the Economic Aspects of Beef Cattle production in Maryland. Sidney Ishee and R. M. Johns.
- A-18-aw Estimating the Returns to Inputs of Capital and Labor on Maryland Cash Grain and Tobacco Farms. J. P. Marshall.
- A-18-ax Organization of the World's Agricultural Resources. P. W. Foster and Graduate Assistant.
- A-18-ay Profitability of Alternative Feed Handling Systems on Maryland Dairy Farms. J. P. Marshall, J. W. Wysong, D. F. Tuthill and Graduate Assistant.
- A-18-az The Transfer of Maryland Farm Real Estate. R. A. Murray and R. D. Reinsul.
- A-19-z An Analysis of Practical Procedure for Equitable Taxation of Agricultural Land and Forest Tracts in Maryland. W. P. Walker and W. D. Gardner.
- A-19-aa The Impact of Economic Investments by Agricultural Product Processing and Marketing Firms Upon the Areas in Which the Investments Are Made. W. D. Gardner.
- A-19-ab United States Private Foreign Investment in Food Processing Plants in Latin America. J. R. Moore and Frank Ladovano.
- A-26-bc Adjustments of Maryland Milk Processing-Distribution Systems and Practices to Changing Condition. G. M. Beal, J. E. Martin and Graduate Assistant.
- A-26-bd Adjustments in Broiler Industry Related to Area Competition and Market Demand. H. D. Smith, J. M. Curtis and Graduate Assistant.
- A-26-bf Improving Auction Warehouse Facilities and Methods of Marketing Maryland Tobacco. G. M. Beal, J. R. Moore, J. M. Curtis and Graduate Assistant.
- A-26-bg Analysis of the Impact of Farmer Cooperatives on the Agricultural Economy in Maryland. R. J. Beiter.
- A-26-bh Trends Pointing to Future Consumption and Market Potential for Meats in the Northeast. H. D. Smith, R. F. McDonald, J. M. Curtis and Graduate Assistant.
- A-26-bi The Effects of Changes in Transportation Rates on the Delmarva Poultry Industry. J. E. Martin, H. D. Smith and G. F. Combs.
- A-26-bj Changes in the Structure of the Northeast Processed Vegetable Industry. D. A. Swope, J. E. Martin, J. M. Curtis and Graduate Assistant.
- A-26-bk Impact of the Chesapeake Bay Bridge-Tunnel on the Marketing of Soybeans, Corn and Feed Derivatives of these Grains, Through the Port of Baltimore. P. W. Foster and Graduate Assistant.
- A-26-bl Changing Structure and Performance of the Northeastern Markets for Grain. J. E. Martin and W. G. Heid.
- A-26-bm The Export Market for Maryland Agricultural Products. J. R. Moore, J. M. Curtis and Graduate Assistant.
- A-26-bn The Application of Distributed Lag Models in the Estimation of Long-run and Short-run Elasticities. J. E. Martin.
- A-26-bo Analysis of Processing Efficiency and Costs in Broiler Processing Plants. J. C. Maness, H. D. Smith and Graduate Assistant.

Department of Agricultural and Extension Education

- T-6 Identification of High School Educational Experiences Affecting the Success of Students in the College of Agriculture. C. R. Smith.
- T-9 Relationship of Undergraduate Academic Achievement in College to Success in Teaching Vocational Agriculture. V. R. Cardozier.
- T-10 Testing a Procedure for the Improvement of the Reading Ability of Pupils in Vocational Agriculture Classes. V. R. Cardozier.
- T-11 A Comparative Study of Selected Farm Mechanical Skills Used by Successful Maryland Farm Operators and Farm Mechanical Skills Taught in Vocational Agriculture in Selected Maryland High Schools. D. M. Tugend and C. R. Smith.

Department of Agricultural Engineering

- R-16 Pneumatic Handling of Chopped Forage. W. L. Harris, G. J. Burkhardt, K. E. Felton, R. L. Green, E. W. Martin, N. E. Collins and J. E. Foster.
- R-18 Development of Equipment and Improved Methods for Harvesting Sweet Potatoes. G. J. Burkhardt, E. W. Martin and R. L. Green.
- R-20 Principles of Separating Crop from Soil in Harvesting Root Crops. G. J. Burkhardt, E. W. Martin, R. L. Green, W. L. Harris, P. N. Winn, L. E. Scott.
- R-21 Development and Construction of Specialized Facilities and Equipment for Use in Agricultural Research. G. J. Burkhardt, W. C. Schaefer, R. L. Green, E. W. Martin and N. T. Norman.
- RB-11-g Tobacco Housing. P. N. Winn, R. L. Green, G. J. Burkhardt, E. W. Martin, N. Martin, O. E. Street and John Hoyert.

Department of Agronomy

- B-43 Soybean Varietal Improvement. J. L. Newcomer, B. E. Caldwell and C. E. Base.
- B-50 Breeding for Better Dent Corn. R. G. Rothgeb and N. A. Clark.
- B-56-g Ladino Clover Breeding, Disease and Insect Investigation. E. H. Beyer.
- B-56-i Breeding of Improved Varieties of Forage Species Adapted to the Northeast. E. H. Beyer.
- B-56-j Pasture Evaluation Using Beef Steers. A. M. Decker, R. Z. Spry and J. E. Foster.
- B-66 Wheat Breeding and Evaluation. R. G. Rothgeb, J. L. Newcomer and J. H. Axley.
- B-67 Varietal Improvement in Barley and Oats. R. G. Rothgeb and Assistants.
- B-68 Effect of Rotational Practices Involving Various Legumes on the Growth, Quality and Composition of Maryland Tobacco. J. H. Hills, C. G. McKee and O. E. Street.
- B-72 Facilitating the Marketing of Seed Through Improved Testing Procedures. J. L. Newcomer.
- B-73 Morphological and Physiological Responses of Perennial Forage Grasses. A. M. Decker, R. Z. Spry and N. A. Clark.
- B-74 The Effects of Nitrogen Rates and Clipping Frequency on the Performance of Midland Bermudagrass (*Cynodon dactylon* (L) Pers.) A. M. Decker.
- B-75 Use of Sod-seeded Forage Crops to Supplement Existing Permanent Pastures. A. M. Decker and W. C. Hulburt.
- B-76 Red Clover Breeding Investigation. E. H. Beyer.
- B-77 Forage Crop Variety Evaluation in Maryland. E. H. Beyer, A. M. Decker and N. A. Clark.
- B-78 The Control of Weeds in Cultivated Crops, Turf and Brush. R. Koontz and J. A. Meade.
- B-79 Use of Herbicides to Control Weeds in Forages. J. A. Meade and R. Koontz.
- B-80 Physiological and Ecological Investigations of the Effect of the Herbicides of Plants. J. A. Meade.

- B-82 Fertility and Clipping Management Effects on the Productivity and Persistence of Annual Pasture Grasses. N. A. Clark.
- B-83 Forage Crop Development Under Controlled Soil Temperature Conditions. A. M. Decker and N. H. MacLeod.
- B-85 Late Planting and Winter Survival in Oats. R. G. Rothgeb and Assistants.
- B-86 A Comparison of Silage Corn Grown Under High and Low Rates of Nitrogen When Fed to Milking Cows. N. A. Clark, J. H. Vandersall and R. W. Hemken.
- B-87 Factors Contributing to Maximum Production in Maryland Tobacco. O. E. Street, J. H. Hoyert and J. E. Murtrey, Jr.
- B-89 Studies of Some Fundamental Physiochemical Relationships of Tobacco with Respect to Cultural, Fertilization, Curing and Fermentation Practices. O. E. Street, D. D. Tyrer, P. W. Winn and T. C. Tso.
- B-94 The Effects of Physical Characteristics of Herbicides on Efficiency and Mode of Action When Used on Corn and Soybeans. J. A. Meade and R. Koontz.
- B-95 Germination and Competitiveness of Crabgrass (*Digitaria spp.*) Under Varying Environmental Conditions. J. A. Meade and R. Koontz.
- B-96 To Study the Effect of Controlled Environment on the Degree of Uniformity of Tobacco Seedlings. J. H. Hoyert and C. G. McKee.
- BG-1 The Comparison of Nitrogen Fertilized Grasses With a Grass-legume Mixture for Lactating Dairy Cows. N. A. Clark, A. M. Decker, R. W. Hemken, J. I. Leslie and R. F. Davis.
- BOQR-84 Climatological Relationship to Plant Growth. O. E. Street, A. M. Decker, Jr., J. H. Hoyert, Edward Strickling, C. W. Reynolds, P. N. Winn, Jr., H. E. Heggsted, H. A. Menser, Jr., J. K. McGuire and W. J. Moyer.
- O-48 Morphologic Studies of Maryland Soils as Related to Classification and Correlation. J. A. Pomeroy and W. F. Sledjeski.
- O-55 Soil Test Studies. John Axley.
- O-57 More Effective Use of Soil and Fertilizer Nitrogen. John Axley, J. O. Legg and J. G. Cady.
- O-62 The Response of Forages and Certain Grain Crops to Fertilizers as Related to Rates and Ratios and Methods of Application. John Axley.
- O-63 Response of Orchard Grass to Various Sources of Nitrogen and their Time of Application. C. B. Kresge.
- O-64 Effect of Nitrogen, Phosphorus and Potassium on the Growth and Development of Forages. C. B. Kresge, D. F. Champion and V. A. Bandel.
- O-65 Legume Grass Mixtures in Relation to Differential Nitrogen Fertilization. C. B. Kresge.
- O-70 Relationship of Soil and Weather to Consumptive Use of Soil Moisture by Selected Field Crops. Edward Strickling, Neri Clark and Carroll Stottlemeyer.
- O-71 Nutrient Balance in Orchardgrass as Related to Differential Fertilization. C. B. Kresge and V. A. Bandel.
- O-72 The Effects of Soil Aeration, Mechanical Impedance and Temperature on Root Growth. Edward Strickling, D. Bandel and J. J. Rasekh.
- J-95 Development of Improved Strains of Maryland Tobacco Resistant to Disease. B. W. Byrd, H. A. Skoog, C. G. McKee, J. H. Mills, H. E. Heggsted and O. D. Morgan.

Department of Animal Science

- C-21 The Effect of Specific Metabolites Upon Growth Rate and General Condition of Sheep. E. C. Leffel and N. Satapathy.
- C-25-a The Effects of Roughage Preparation. E. C. Leffel, A. Adare and B. B. Mahapatro.
- C-33 A Study of the Effect of Menhaden Fish Meal on the Quality of Protein of Swine Diets and on Total Crude Protein Requirements for Growth of Swine. E. P. Young, J. E. Foster, D. G. Snyder and R. R. Kifer.
- C-34 A Study of the Nutritional and Physiological Influences on Variability of Ovulation Rate and Embryonic Survival in Swine. E. P. Young, W. W. Green and J. E. Foster.

- C-35 Studies on the Efficiency and Composition of Growth in Swine as Affected by Protein and Energy Consumption. E. P. Young and R. C. Leffel.
- C-36 A Study of Factors Affecting the Utilization of Non-protein Nitrogen in High Roughage Diets for Ruminants. E. C. Leffel, N. Satapathy, B. B. Mahapatro and J. E. Foster.
- C-38 A Study of Factors that Influence Feed Consumption by Suckling Pigs. E. P. Young, R. E. Fowler and J. E. Foster.
- C-39 Analyses of Records of Beef Cattle Herds in Maryland. W. W. Green, John Buric, J. E. Foster, J. Lingle and J. L. Carmon.
- C-40 A Study of the Use of Measurements for the Evaluation of Beef Breeding Cattle. W. W. Green, W. R. Stevens, John Buric, J. E. Foster, Joe Lochte and J. L. Carmon.
- C-41 A Study of Variations in Values of Criteria Used in Selection Indices for Beef Cattle. John Buric, J. E. Foster and W. W. Green.
- C-42 A Study of Rates of Ruminant Digestion and Absorption from the Rumen. E. C. Leffel, R. W. Farmer, M. H. Abbassy and J. E. Foster.

Department of Botany

- F-12 The Native Plants of Maryland, Their Occurrence, Distribution and Economic Importance. R. G. Brown.
- F-18 Genetic Control of the First Division Association of Homologous Chromosomes and Fertility in *Zea mays* and *Capsicum frutescens*. D. T. Morgan and R. L. Baker.
- F-19 Anatomical Physiological and Ecological Studies on *Myriophyllum Spicatum* L. R. G. Brown, R. D. Rappleye, Richard Anderson and H. Weirick.
- F-20 An Ecological Study of the Patuxent Estuary. R. G. Brown, R. D. Rappleye, Richard Anderson, Richard Sommer and Charles Phillipp.
- J-91 Fungicidal Materials on Cellular Metabolism and Their Usefulness for the Field Control of Vegetable Diseases. H. D. Sisler, J. G. Kantzes, M. R. Siegel, R. A. Paterson and graduate assistants.
- J-93 Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases. O. D. Morgan, J. G. Kantzes, L. R. Krusberg, A. A. Bell, F. J. Williams, W. L. Klarman and E. H. Beyer.
- J-95 Development of Improved Strains of Maryland Tobacco Resistant to Diseases. O. D. Morgan, O. E. Street, John Hoyert and E. H. Beyer.
- J-97 Physiology of Plant Parasitic Nematodes and the Plant Nematode Interaction. L. R. Krusberg, R. F. Myers, R. K. Howell and J. M. Taylor.
- J-98 Identification, Characterization and Control of Certain Viruses Affecting Economic Plants in Maryland. H. D. Sisler and O. D. Morgan.
- J-99 The Nature and Control of Diseases of Ornamentals and Turf Grasses in Maryland. W. L. Klarman, A. A. Bell and Graduate Assistants.
- J-100 Nature and Control of Major Field and Storage Diseases of Sweet Potatoes in Maryland. J. G. Kantzes and J. M. Wells.
- K-8-c Biophysical and Biochemical Factors in Plant Nutrition. H. G. Gauch, Robert Krauss, Raymond Galloway, John Bowen and Mohamed Abdul Halim.

Dairy Science Department

- G-34 Chemical Changes in Milk Fat as Related to the Flavor of the Milk. R. L. King, W. F. Williams and Mark Keeney.
- G-35 The Analysis of Dairy Products. J. F. Mattick, Mark Keeney and R. L. King.
- G-37 Physiology of Metabolic Diseases of Cattle. W. F. Williams, J. D. Connally, W. E. Stewart and R. W. Hemken.
- G-39 Studies on the Mode of Digestion, Absorption and Utilization of Feeds by Ruminants and their Associated Bacteria. W. E. Stewart, J. Nicolai, H. F. Downey, J. C. Smith, C. Coppock, R. N. Doetsch, R. F. Davis and Mark Keeney.

- G-40 Influence of High Temperature Heat Treatment on Certain Physical and Chemical Properties of Milk. I. A. Gould, F. G. Warren, Mark Keeney, J. F. Mattick, W. S. Arbuckle, P. B. Larson, B. C. Johnson, T. A. Fitzpatrick, P. Strogyl and I. D. Rifaat.
- G-42 Methods of Processing and Other Factors Affecting the Quality of Ice Cream. W. S. Arbuckle and R. L. King.
- G-46 The Relationship of the Hypophyseal Growth Hormone and of the Pituitary-Adrenal System to the Productive Capacity of Dairy Cattle for Reproduction and Milk Production. W. F. Williams, H. H. Head and J. Lynch.
- G-47 The Nutritive Evaluation of Forages. R. W. Hemken, R. F. Davis, N. A. Clark, A. M. Decker and J. H. Vandersall.
- G-48 Flavor Quality of Concentrated Milk Products as a Factor in Milk Utilization and Marketing. Mark Keeney, Ira Katz, J. E. Kunsman and R. L. King.
- G-50 The Physiology of Progesterone Metabolism. W. F. Williams and G. D. Turner.
- G-51 A Study of the Effects of Pelleting and Heating of Feeds Upon Body Composition, Growth and Milk Secretion in Ruminants. J. H. Vandersall.
- G-52 A Study of Factors Affecting the Voluntary Intake, Availability and Utilization of Nutrients in Forages for Growth and Milk Production. J. H. Vandersall, R. W. Hemken, N. A. Clark and R. F. Davis.
- G-53 A Study of the Development, Improvement or Standardization of Manufacturing Processes for the Production of Various Cheeses and the Effect of Specific Factors on the Flavor, Body and Texture of these Cheeses. J. F. Mattack.
- G-54 Analyses of Production and Feed Data from Dairy Records. J. L. Cason.
- GC-45 Studies of the Physiological and Biochemical Nature of Bloat. W. E. Stewart, E. C. Leffel, J. C. Smith and R. N. Doetsch.
- BG-2 Grazing Study with Lactating Dairy Cows on Summer Annual Pastures. N. A. Clark, R. W. Hemken and J. H. Vandersall.

Entomology Department

- H-29-n Chemical Control of Insect Pests of Sweet Corn. L. P. Ditman and F. P. Harrison.
- H-46-e Concentrated Pesticide Sprays. Evaluation of New Insecticides on Vegetable Crops. L. P. Ditman, J. G. Burkhardt, W. E. Bickley and Graduate Students.
- H-48 Control of the Codling Moth and Careful Observations on Possibility of Resistant Strains. Castillo Graham and E. R. Krestensen.
- H-61 The Biology and Distribution of *Macropsis Trimaculata* Fitch. W. E. Bickley, Castillo Graham and E. R. Krestensen.
- H-64 An Evaluation of the Effectiveness of Commercial Insect Control Practices on Canning Crops. L. P. Ditman.
- H-67 Insecticidal Residues on Vegetable and Forage Crops. L. P. Ditman and Mrs. Katherine Nelson.
- H-69 Identification and Control of the Various Species of Mites Causing Damage to Apple Orchards. W. E. Bickley, Castillo Graham and E. R. Krestensen.
- H-71-d Alfalfa Insects, Their Biology and Control. A. L. Steinhauer and H. D. Bryn.
- H-72 Physiology of Insect Reproduction. J. C. Jones and E. S. Krafur.
- H-73-a The Mosquito Fauna in Selected Swamps, Marshes and Impoundments. W. E. Bickley and Graduate Students.
- H-74 Biology and Control of Tobacco Insects. F. P. Harrison.
- H-76 Comparative Morphology and Physiology of Insect Blood Cells. J. C. Jones, Mrs. D. P. Liu, R. E. Wheeler and W. M. Eckholm.
- H-78 Metabolism of Essential Nutrients and Insecticidal Chemicals in Insects. A. L. Steinhauer and Graduate Students.
- H-79 Classification of Green Lacewings (Chrysopidae: neuroptera). W. E. Bickley and R. A. Bram.
- H-80 Classification of the Neotropical Mosquitoes of the Subgenus *Culex*. W. E. Bickley and R. A. Bram.

- H-81 Utilization of the Polyhedrosis Virus for Commercial Control of the Cabbage Looper. L. P. Ditman and Graduate Students.
- H-82 Chemosterilization of Insects. W. E. Bickley and Graduate Students.

College of Home Economics

- Y-1 The Effect of Different Quality and/or Quantities of Dietary Protein on Serum Lipid Levels. Pela Braucher, Virginia Dawson, Genevieve Watkins, E. C. Cox and L. M. Dyke.
- Y-2 Properties of Textile-Furnishing Fabrics and their Importance to Consumer Satisfaction. Eleanor F. Young and T. Faye Mitchell.
- Y-3 Fertilization Effects on the pH, Titratable Acidity, Chlorophyll and Carotene Content of Broccoli. Mary S. Eheart and Claire Gott.
- Y-4 Utilization of Amino Acids from Proteins. Pela Braucher, Virginia Dawson, Genevieve Watkins and L. M. Dyke.

Department of Horticulture

- 1-74-a Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Potted Plants. J. B. Shanks, C. B. Link and Frank Marousky.
- 1-74-b Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops. C. B. Link, J. B. Shanks, James Swasey and Francis Gouin.
- 1-79-l Physiological Differences of Winter and Summer Flowering Varieties of Snapdragons as Related to Growth and Flower Quality. C. B. Link, Kenneth Sanderson and J. B. Shanks.
- 1-79-m Relationship of the Mineral Nutrients and of Nutrient Levels to the Growth and Development of Certain Woody Ornamental Plants Growing in Containers. C. B. Link and Francis Gouin.
- L-74 Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits. A. H. Thompson and B. L. Rogers.
- L-74-b Chemical Thinning of Apples and Peaches. A. H. Thompson and B. L. Rogers.
- L-79-a Relation of the Level of Mineral Nutrients in the Plant to Growth and Fruiting of the Strawberry with Particular Reference to Nitrogen. L. E. Scott, G. J. Stadelbacher and H. S. Todd.
- L-79-e Mineral Nutrition of the Apple with Reference to the Development of Cork Spot and to Respiration, Enzyme Activity and Storage Life. A. H. Thompson, W. J. Bramlage, B. L. Rogers, J. A. Barden and H. G. Gauch.
- L-79-f Post Harvest Physiology of Pomological Fruits.
- Q-58-a Rapid Nutritive Evaluation of Processed Vegetables. Amihud Kramer, L. E. Scott and E. M. Ahmed.
- Q-58-m Development of New Products and Improved Processing Methods. R. C. Wiley, Amihud Kramer, B. A. Twigg, L. E. Scott, M. Modery, J. L. Collins and T. Chase.
- Q-58-n Suitability of New Varieties of Horticultural Crops for Canning and Freezing. W. L. Hollis, B. A. Twigg, Amihud Kramer, F. C. Stark and L. E. Scott.
- Q-58-p Quality Improvement of Canned Apple Slices and Sauce Through Studies of the Relation of Water Insoluble Constituents of the Fresh Fruit to the Textural Quality of the Processed Product. R. C. Wiley, A. H. Thompson, M. Modery, J. L. Collins, D. White and T. Chase.
- Q-58-r Quality Maintenance; Measurement and Control in the Marketing of Vegetables Including Potatoes. Amihud Kramer, R. C. Wiley, B. A. Twigg, W. L. Hollis, Mildred Modery, S. Palmer and John Yeatman.
- Q-58-s Quality Maintenance, Measurement and Control in the Marketing of Vegetables Including Potatoes, Amihud Kramer, I. Ben-Sinai, B. A. Twigg and G. J. Burkhardt.

- Q-74 A Study of Region Adaptation of Certain Vegetable Crops and Varieties in Maryland. W. L. Hollis, F. C. Stark, C. W. Reynolds, L. E. Scott and W. A. Matthews.
- Q-77 Crop Management Studies with Vegetable Crops. W. L. Hollis and F. C. Stark.
- Q-77-b Efficacy and Selectivity of Chemical Herbicides for Controlling Major Weed Species in Truck Crop Production. J. D. Riggelman, W. A. Matthews, G. J. Stadelbacher, and F. C. Stark.
- Q-79-h Influence of Nutrient Intensity and Balance on the Growth, Yield and Quality of Cauliflower. C. W. Reynolds, F. C. Stark and A. G. Alexander.
- Q-81 Cantaloupe Breeding and Selection with Particular Reference to Quality and Resistance to Defoliation. F. C. Stark and W. A. Matthews.
- Q-81-b Sweet Potato Breeding and Selection with Particular Reference to Quality and Resistance to Cracking. F. C. Stark, W. A. Matthews, L. E. Scott, and J. D. Riggelman.
- Q-81-c Sweet Corn Breeding with Particular Reference to the Utilization of Cytoplasmic Male Sterility in the Production of F₁ Hybrid Seed Corn. R. J. Snyder and F. C. Stark.
- Q-81-d Tomato Breeding and Selection with Particular Reference to Adaptation to Mechanical Harvest and to Processing. F. C. Stark and J. D. Long.
- Q-83 Soil and Plant Factors Affecting Water Utilization by Selected Vegetable Crops. C. W. Reynolds and F. C. Stark.
- Q-83-b Root Distribution and Root Density of Selected Vegetable Crops as Related to the Absorption of Soil Water and the Uptake of p³². C. W. Reynolds.

Poultry Science Department

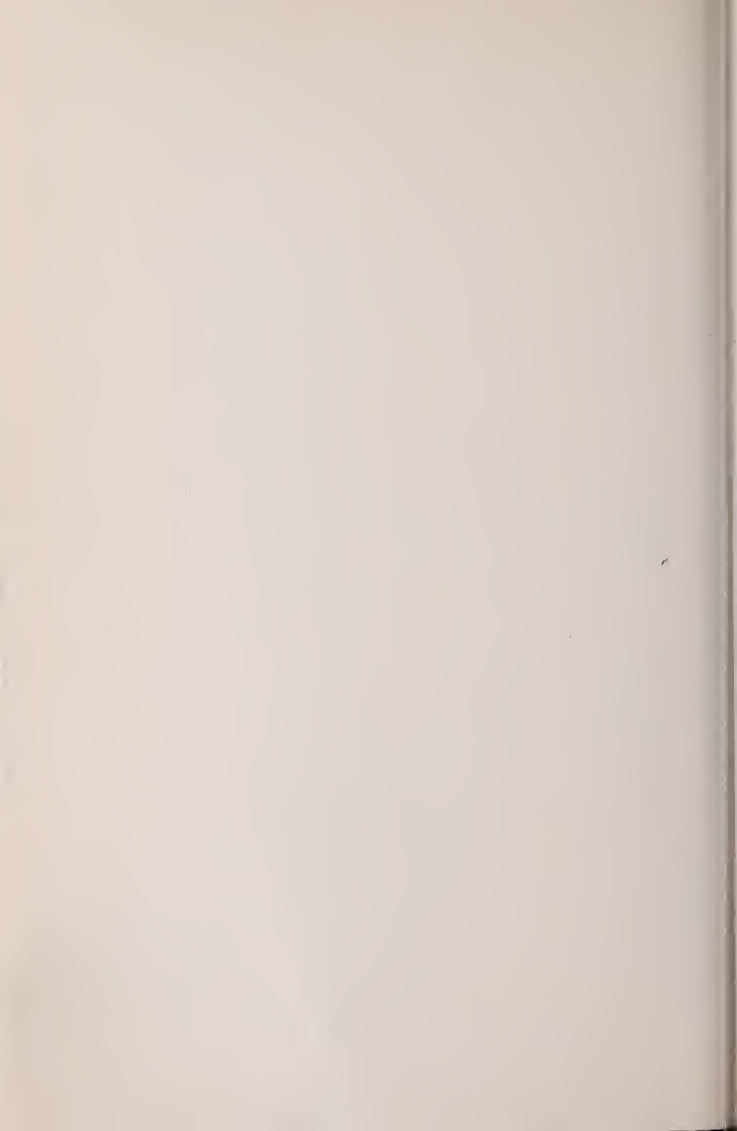
- M-32-m Genetic Differences in Alkaline Phosphatase Concentration of Blood Sera as Related to Differences in Egg Production and Egg Quality. F. H. Wilcox, C. S. Shaffner and W. S. Cloud.
- M-33-e Genetic Control of Serum Cholesterol Level. F. H. Wilcox, C. S. Shaffner, F. L. Chermis, L. D. Hardy, J. C. Harris, C. E. Clark, L. D. VanVleck, W. R. Harvey, H. R. Wilson and H. V. Auger.
- M-55 The Perception and Preference of Chickens for Different Colors. G. D. Quigley.
- M-57 Genetic or Other Explanations of Variation in Louse Numbers on Poultry. C. D. Quigley.
- M-58 Metabolic and Nutritional Studies on Microorganisms Important to the Poultry Industry. Mary S. Shorb, Pauline G. Lund, Brian Dunlap and Winifred Kneuse.
- M-59 Lipid Metabolism of Fowl Spermatozoa. Mary S. Shorb and Brian Duncan.
- M-60 Test of an Insecticide (Co-Ral) as a Systemic Insecticide for Poultry. G. D. Quigley and W. G. Harding, Jr.
- M-61 A Study of Causes of Bruising in Transportation of Live Broilers from Farm to Processing Plant and Possible Methods for their Reduction. H. V. Helbacka and D. H. Saunders.
- M-100 Quality Retention in Poultry Meats as Influenced by Methods of Processing. N. V. Helbacka, C. S. Smith, A. Kotula and C. S. Shaffner.
- M-200 Studies on Improved Broiler Nutrition. G. F. Combs, J. L. Nicholson, N. V. Helbacka, R. D. Creek, D. L. Pope and J. L. Milligan.
- M-201 Vitamins and Unidentified Organic Factors in Poultry Nutrition. G. F. Combs, W. C. Supplee, R. D. Creek, J. L. Nicholson, B. Panda, G. R. Childs, D. L. Pope, and D. L. Blamberg.
- M-202 Protein and Amino Acids in Poultry Nutrition. G. F. Combs, D. T. Middendorf, P. F. Twining, D. L. Pope, A. Spansdorf, E. H. Bossard, D. L. Blamberg, J. L. Nicholson, G. R. Childs, J. L. Milligan, and R. D. Creek.
- M-203 Trace Minerals in Poultry Nutrition. W. C. Supplee, G. F. Combs, R. D. Creek, N. V. Helbacka and O. D. Keene.
- M-205 Mycotoxins as Related to Poultry Nutrition and Various Unidentified Poultry Maladies. R. D. Creek, H. M. DeVolt and N. C. Laffer.

- M-302 Effect of Freezing and Reversible Inhibitors on Chicken Sperm. F. H. Wilcox and C. S. Shaffner.
- M-303 The Performance of Populations of the Domestic Fowl as Influenced by Heritable Physiological Traits and by Genes with Pleiotropic Effects. F. H. Wilcox, C. S. Shaffner and W. S. Cloud.
- M-400 Effect of Protein Adequacy on the Efficiency of Selection for Early Fattening of Turkeys. C. S. Shaffner, G. F. Combs, G. D. Quigley and D. H. Sanders.

Department of Veterinary Science

- D-52 Respiratory Diseases of Poultry. F. K. Wills, I. M. Moulthrop, H. M. DeVolt and J. K. Noel.
- D-57 Epizootiology of Equine Encephalitis in Maryland. R. J. Byrne, M. J. Collins, Jr., Frances S. Yancey, R. W. March and H. M. DeVolt.
- D-58 Infectious Bovine Mastitis. E. J. Schultz.
- D-59 The Investigation of Fluorescent Antibody Technique with Respiratory and Other Diseases of Poultry. H. M. DeVolt, R. W. Peters and Willene Keenum.
- D-60 Investigations on Brucellosis of Cattle. Cornelia M. Cotton, A. J. Kowalk and Donna Boschert.
- D-61 A Study of Ruminant Metabolism with Emphasis Upon its Relation to Ketosis. R. B. Johnson.
- D-62 Infectious Diseases Affecting Reproduction in Cattle with Special Reference to Vibriosis and Leptospirosis. G. J. Plumer, V. M. Shepler, F. S. Yancey and W. R. Anderson.
- D-63 Study of Bovine Respiratory Diseases. R. J. Byrne, S. B. Mohanty, M. Lillie and G. J. Spahn.
- D-64 An Investigation to Study the Propagation of Avian Viruses in Tissue Culture. H. M. DeVolt, V. M. Hayer and Willene Keenum.
- D-65 Studies on Etiology and Pathogenesis, Laboratory Diagnosis and Chemotherapy of Bovine Lymphosarcoma. B. C. Hatzios.









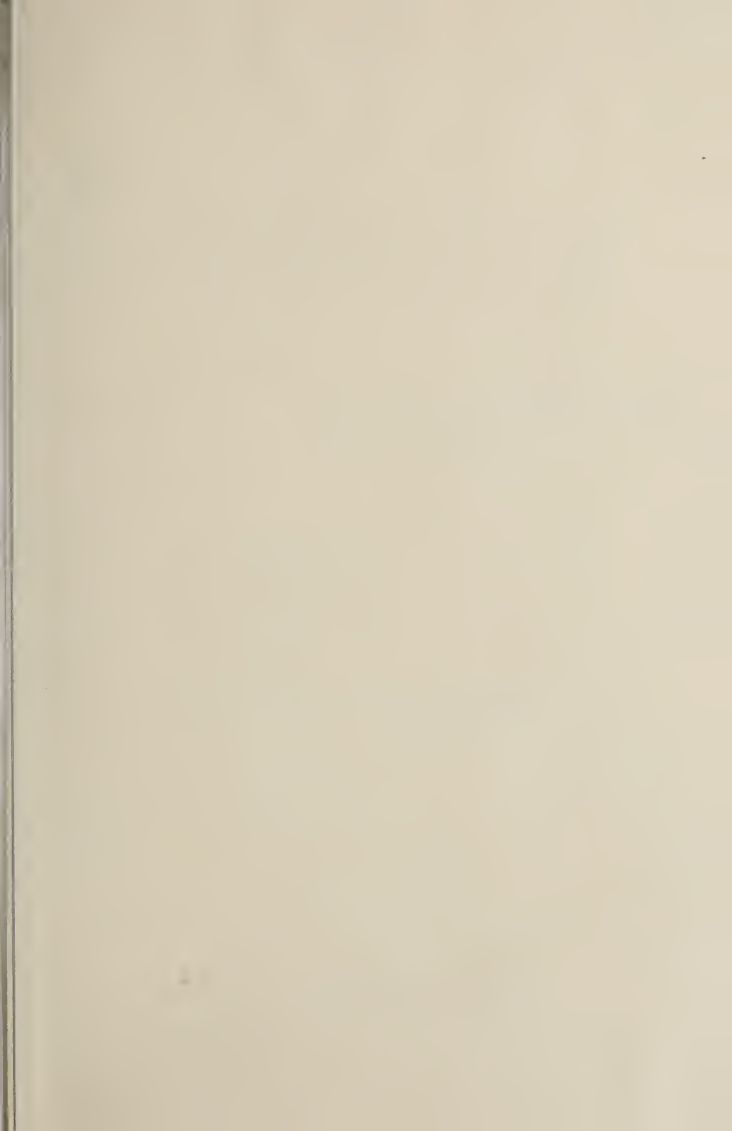
In addition to state and federal funds, the research program of the University of Maryland Agricultural Experiment Station has received support during the year from many public, private and industrial organizations and individuals. It is regretted that space does not permit recognition of all sources of help, but the cooperation of all is herewith gratefully acknowledged.

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